ENGINEERING

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Quality

In an engineering firm there is nothing so important, but so difficult to change, as the quality of its work. It is a matter of policy which is settled, deliberately or haphazardly, when the firm is founded, and it becomes so much a part of the business that new staff absorb it unconsciously, deriving it from the atmosphere of the firm rather than from any written instructions. Even if they manage to raise or lower the quality, the chances are that a generation must come and go before the firm's customers have adjusted their conception of the firm's reputation for quality.

Henry Royce must have been a very far-seeing man. In establishing the principle of high quality for which his firm is famous, he was not adopting a policy which would automatically pay off; most customers, whether for motor-cars or any other product, are prepared to accept something less than the best because they know they will get it cheaper. But there is room at the top for one—seldom more—and for the firm which fills that rôle there is a certain basic simplicity in playing it. The firm which chooses to have a policy of reasonably high quality, however, without being the best and most expensive, has in some ways a more difficult task. The level of quality has to be established in terms which can be understood throughout the organisation, and then year by year that level has to be maintained in spite of the conflicting requirements of customers and the differing opinions of the staff.

Since quality in engineering manufacture is evidently so important it is surprising to find that it does not receive the same attention as do the more obvious functions like design, production and selling. Special interest therefore attaches to a paper which the chief quality engineer of Rolls-Royce Limited, Mr. Frank Nixon, gave to the Institution of Mechanical Engineers last week. It was entitled "Quality in Engineering Manufacture" and was one of a large number of papers at the Conference on Technology of Engineering Manufacture which that institution arranged. The basic conception of the conference was admirable because well over half the engineers employed in manufacturing industry are engaged in production, rather than design or research. Mr. Nixon showed that in deciding on an acceptable level of quality an engineering firm takes a calculated risk. The cost of obtaining increased quality goes up very steeply as the ideal of no defective parts is approached, and eventually the increase in goodwill is found to be costing too much.

The Margin of Safety for a component is the difference between the quantities of which the Factor of Safety is the quotient. Mr. Nixon showed a diagram in which he displayed all the things which affect the margin of safety. The diagram was drawn for the common case where the design has been based on static assumptions, with a large and comfortable so-called factor of safety. "In real life," Mr. Nixon says, "the assumed strength of the material will usually be found to be diminished, in greater or lesser degree, by the inflationary tendency of the maker's catalogue; by scatter throughout the production batch, due to factors which it may not yet be possible to assess or to control; by the deleterious effects of defects such as laps, seams, roaks, inclusions, blowholes, quenching cracks, forging cracks, overheating and so on, which may have been left undetected; and by the fatigue effect, where the endurance limit is only a fraction of the ultimate strength. In its turn, the calculated working stress will often be lower than the true stress because no account may have been taken of the stress-raising effect of holes, keyways, fillet radii, scratches, notches or poor finish; the applied loads will often have been assumed without regard for the possibility of occasional overloads through misalignment, vibration and bad handling, for example; the effects of undersize sections, or even of the smallest sections occurring within the allowed tolerance, may have been ignored; the methods of stressing will often have been by rule-of-thumb approximations; and wear and corrosion may also have played their part." Thus the true margin of safety will be greatly diminished. The difference between the apparent margin of safety and the true margin of safety may be called the margin of ignorance. Success will be assured, Mr. Nixon says, as long as the margin of ignorance is less than the apparent margin of safety, but "the greater the margin of ignorance, the lower will be the product in the scale of technical achievement."

Quality of production is very near to the hearts of engineers, but if a firm is not careful such a strong tradition gets carried over into aspects of policy with which it has little connection; it may lead to stagnation in design because the sense of tradition is stronger than the spirit of innovation. The great firms are those which combine quality of production with enterprise in research, development and design.

Cover Picture. *The 90 kW pit-type electric furnace shown is to be used for isothermal annealing. Its maximum temperature is to be 900° C and the usable working space will have a diameter of 30 to 32 in and be 44 in deep.*

(*Nurnberg photograph for* ENGINEERING)

★ ★ ★

Plain Words

A severe gale, a heavy sea, and another piece of land disappears. If a house stood on the land, or if it were a favourite cliff walk, then there is a subject for a spectacular treatment by the Press. Big, dramatic photographs—what an excellent job the Press photographers do. Yet it is the excellence of their work which has one unfortunate corollary, for it tends to highlight the isolated instance of coastal damage and thereby obscure the continual, everlasting erosion of the coast that goes on unchecked.

Unchecked. No, I'm not quite right there. On reflection, I can think of a lot of work going on to defend our shores. Many local authorities, some big, some small, some with grants from the Government, a few without, are having a go at fighting what so often seems to be a losing battle against the sea. When I say our shores, I mean Britain's of course. What is done in foreign countries? Some—like the Dutch—have to toil unceasingly or they wouldn't be there at all; others don't do anything at all, because they don't have to. We don't come in either category—we do have to do something about it where there is property, but things haven't been quite so desperate that we've had to do something all along the line.

If we had had to defend every inch of our coastline some overall thought would be given to the problem. Perhaps there is. Certainly an official in Whitehall has to choose between the conflicting claims of various local authorities' schemes. That's the worst of it, though, because if you do push the sea back at one point, it goes somewhere else—sometimes nearby. It's a subject that needs a lot of data before it can be thought about to any effect, or before anything can really be done effectively and economically. Given adequate knowledge, and being sure of supporting works in adjacent areas, it is frequently possible to stabilise the beaches with only the lightest of constructions.

The first necessity, surely, of any full consideration of erosion around our coasts is to encourage collaboration in obtaining accurate field data. Levels of the sea-bed are wanted to at least beyond the five-fathom contour; they must be obtained by sounding and reduced to the land survey datum. Samples of the bed—sands or shingles—have to be taken and efforts made to find out what is, and has been, happening in the very vital unrevealed areas to the storm-windward of our ever-eroding coastlines.

All too frequently in the past, the problem of coast protection has been tackled on a parochial scale—too limited resources being strained to provide a bastion for a particular stretch of coastline, often having regard only for the leases of valuable properties which are liable to deteriorate or disappear. But a fuller appreciation of what is required is growing. Many of the lessons to be learnt from *ad hoc* solutions are known. The time is ripe and the experience available to consider successfully all 4,000 miles of our coastline as a single continuous interdependent whole.

CAPRICORN

Weekly Survey

Subsidies for Everyman

A number of unions are casting around for reasons why they should be conceded wage increases on a falling market. Among them, the miners and the railway operatives have both looked in the direction of economic feather bedding. The miners have suggested that it would be reasonable to control the volume of oil imports in favour of indigenous coal. The railwaymen have said that if it is right to subsidise agriculture, it is right to subsidise the railways.

It is true that once the principle of subsidising an industry is admitted it is exceedingly difficult to draw a logical line and say that one industry shall be subsidised and another not, but even when this difficulty is admitted the railwaymen are still not on firm ground. It is possible to say, as is indeed argued successfully for the agriculture industry and has often been argued rather less successfully for the railways, that an industry is strategically important and must be kept in being. The principle is also admitted for such industries as aluminium and would no doubt be invoked in times of acute depression for basic industries such as coal and steel.

It is one thing to say, however, that an industry must be kept at some preconceived level of capacity and quite another to argue that wages in such an industry should be pushed up every time there is negotiating pressure from the union. It is also wrong to assume that because there is something in the strategic argument it follows that the current capacity of an industry, its present organisation, labour force and wage levels should be assumed to be the right level and that either management or labour can accept that datum line for future development and negotiation. Subsidies are fairly popular devices for various kinds of economic planners but they can become nonsense, as the last decade has only too clearly shown, when exposed to the pressures arising from collective bargaining.

Forbidden Fruit

Representatives of Chinese state trading corporations are expected here shortly with powers to make buying contracts for a wide range of goods. This is the first follow-up of the Chinese Economic and Technical Mission which came to this country last autumn. This mission draws attention once again to the growing restlessness over the embargo regulations enforced by the NATO Communist Trade Committee. This committee has recently completed its preliminary survey of the trade embargo position with the Communist bloc and this will be going forward for formal discussion after Easter by delegates from all the NATO countries. It will be recalled that, last year, the embargo was relaxed to bring China into line on the list with other communist countries, much to the chagrin of the United States representatives. It is already known that the European members of NATO will press for a further relaxation of the embargo in a few weeks' time. The Paris report comes on top of the much publicised row in Canada, where a United States subsidiary has been forbidden to trade with a Communist country.

The embargo has been an irritant, straining relationships among the Western powers for several years. Its economic disadvantages may well have been over-emphasised, for the trading potential of some Communist countries is severely limited by a shortage of foreign exchange. There have been, however, some glaring examples of orders for capital equipment lost because of the embargo. The urge to look east is all the stronger at present owing to the American recession which many western European countries fear will be exported eastward across the Atlantic very shortly. To many Europeans, the United States is in the equivocal position of putting its internal economic affairs in order with scant attention to the international consequences (since European exports to the United States are thereby jeopardised) while putting political pressure on its allies to continue forgoing trade outlets in other directions.

Ambient Comfort

A substantial contribution to research on heating and ventilating problems is being made by the Heating and Ventilating Research Council. In their second annual report they say that, "1957 was a period of building up from the small beginnings of 1956." The research programme has now been established on a firm basis and an extension of the projects in hand is being considered. There has been a considerable strengthening of the Council's financial position, mainly due to a 50 per cent increase in annual subscription rates promised by the contractors. Together with the grant aid from D.S.I.R. income in 1958 will exceed £17,000 and the results of a membership drive have been most encouraging. The member firms include 163 contractors, 29 consulting engineers, nine makers of automatic controls and 19 others.

Two well-known experts have been nominated by D.S.I.R. as their official visitors, whose main purpose is to maintain contact with the Research Council and to provide the D.S.I.R. with an independent appraisal of the organisation and its work. One of them, Dr. R. J. Sarjant, was latterly Professor of Fuel Technology at Sheffield University and the other, Mr. Thomas Mitchell, is a member of the Science Committee of the Royal Institute of British Architects. The research programme is being limited to some extent by a shortage of suitably qualified staff. Emphasis is being placed on field investigations. First priority has been placed on research into the design and performance of high-velocity ventilation systems and on the study of the application of automatic controls to heating and air-conditioning plants. The latter project has developed logically from the intermittent heating investigation in which, the report states, "it clearly assumes a very important aspect."

The intermittent heating programme has increased interest in the assessment of individual room heating arrangements and their environmental and control problems. Account is being taken of both home and recent Continental developments in this direction and the possibility of constructing a test cabinet is currently being considered. Experiments have continued in a London block of offices in intermittent heating techniques, primarily to establish suitable methods of analysis which ultimately can be applied to other installations and so speed up the subsequent flow of results. The high-velocity ventilation project, which was prompted by major developments that have taken place in this direction in the United States, has for its main object the saving of building space, materials, fabrication and site labour, while avoiding high operating costs resulting from an excessive fan horsepower requirement. Both projects are of major importance and the Council are to be congratulated on the appropriateness of their selection.

Restrictive Practices

It is not at all easy to assess the progress made under the Restrictive Trade Practices Act. The Board of Trade last week issued their third direction to the Registrar of Restrictive Trading Agreements, laying down those agreements which should receive priority in reference to the

Restrictive Practices Court. Substantially all the 2,000 or so agreements which require registration have now been lodged with the Registrar and the first cases are expected to come before the Court in October. The Board of Trade has so far directed the Registrar to bring up about 450 agreements covering over 60 products. Progress on the first few cases must inevitably be fairly slow but it is hoped that by selecting in the first instance agreements which embody practices common to a number of others, a body of " case law " will be established which will enable industry to adjust its practices without waiting for detailed court proceedings.

A number of agreements, notably those containing provision for collective price maintenance which is illegal under the 1956 Act, have been modified before registration and in a few cases agreements have been abandoned altogether. An example of the latter is provided by the demise of the Electric Lamp Manufacturers' Association. Following a report of the Monopolies Commission, E.L.M.A. had already abandoned the fixing of sales quotas and provision for exclusive dealings and, after the passing of the 1956 Act, the fixing of common manufacturers' prices was also brought to an end.

In other cases collective price fixing has been abandoned in favour of the maintenance of re-sale prices by individual manufacturers, which was condemned by a majority of the Monopolies Commission but is permitted under the 1956 Act. Such changes while complying with the law, may not always result in much greater freedom of competition, and much will depend on the interpretation of the relevant sections of the Act by the Restrictive Practices Court. For example, the whole system of fixing discounts for distributors on an approved list, which is a feature of the revised scheme adopted by the motor industry and others, is one which is to come before the Court under the latest direction. Up till the present, while there has been some slight relaxation of restrictive practices, no very marked increase in competition appears to have occurred. Moreover, the relaxations which have occurred probably owe as much to the ending of the seller's market in many fields as to the operation of the 1956 Act.

A Momentous Year

The progress and prospects of the electrical engineering industry are reviewed in the forty-seventh annual report of the British Electrical and Allied Manufacturers' Association (BEAMA). The dominant influence in the past 12 months has been " the background of general world economic conditions and the effects of the economic and financial policy of the Government." Profits have been harder to earn: in manufacturing there has been " a continual struggle to offset rising costs " and in selling " keener competition has had to be faced both at home and abroad." BEAMA point out that the current figures of employment in the industry —727,700 in December 1957, 23,000 more than 12 months before—do not reveal the effects of a recession. " Nevertheless," the report states, " the opinion is that these figures should not be taken as a criterion of future prospects, as the level of employment in the industry is bound to be affected sooner or later by the state of the country's economy and the Government's financial policy." Much of the apparent improvement in the situation over 1956 has resulted from the recovery of the lighter side of the industry, particularly those engaged in the electric household appliance market, which has suffered most during the previous 12 months as a result of the credit squeeze.

BEAMA give their full backing to the Government's attempts to tackle " the continuous problem of inflation which threatens to nullify all its attempts to put the national economy on a sound footing." But they warn that particular care must be taken that high interest rates and restrictions on credit do not result in a reduction of expenditure on research, development and technical education—because " it is on these long-term factors that the future prosperity of a highly technical and competitive industry such as the electrical manufacturing industry so vitally depends."

The review of developments in the electricity supply industry suggests that 1957 has indeed been " a momentous year for the supply industry." The programme of new construction entrusted to the new Generating Board is described as " bold and ambitious." The exploitation of nuclear fusion is described as having reached a stage " when fears of a world shortage of power in the next few years can be discounted."

In fact, the future is full of promise, in almost every direction: the home programme of electrification, the export of electrical machinery (on which the European free trade area looms larger than ever), the closer co-operation of world manufacturers (interchange of information, patents, know-how, personnel and advances in the adoption of international standards)—all of which point to a continued period of expansion and prosperity.

The Budget Approaches

The reduction of Bank Rate has led many to expect some softening in the Government's attitude to taxation. In particular, industry has been conscious of a general decline in activity due to falling investment, and some steps are expected in that direction when Mr. Heathcoat-Amory opens his dispatch case. The Federation of British Industries made a vigorous call for reduction in profits tax, income tax and petrol duty and submitted a number of recommendations to the Chancellor, which were largely technical in character. In making these the FBI urged (*a*) that in view of the inflation that has taken place during the past 15 years, the time is opportune for bringing depreciation allowances into line with present values, and (*b*) that if the proposed European free trade area is set up, " the competitive power of British industry should not be hobbled by unfavourable differences between the United Kingdom and other tax systems."

The surprise proposal was for a reduction in the tax on petrol and associated hydro-carbon oils from 2*s.* 6*d.* to 2*s.* a gallon, which would cost £60 million in a full year. This, the FBI argue, would " especially benefit freight and public passenger transport and so contribute to a reduction of prices on the widest possible scale." The Chancellor may well find himself in agreement, since the downward movement in prices which has taken place over the past few weeks (culminating in the cut in steel prices announced last week) could spread widely and gather momentum if it received this type of official encouragement.

The Engineering Industries Association argued against a large Budget surplus, " which may in itself be an inflationary influence " and also called for a cut in petrol duty and certain surtax and income tax reliefs. There is little doubt that the case for less taxation is a strong one, as we move into an almost forgotten world of intense foreign competition. British industry cannot compete effectively under heavy handicaps of a high rate of profit tax and inadequate investment allowances on plant and machinery. Something needs to be done urgently to make the growth of industry possible under competitive conditions, and both the FBI and the EIA recommendations make good sense in this context. The call for the removal of purchase tax on domestic electric appliances by the British Electrical Development Association is less likely to find favour. Yet anomalies do exist in the purchase tax structure and their arguments are sensible enough.

The main point of doubt arises over the desirability of diverting too large a proportion of the country's resources to the manufacture of consumer goods.

Letters to the Editor

ACCELERATED CURING TESTS ON CONCRETE

SIR, I read with great interest the paper on accelerated curing of concrete by Mr. N. N. B. Ordman and Dr. N. G. Bondre (ENGRG., 21 Feb. '58, p. 243). It is necessary, however, to point out that my law, as stated in the *Magazine of Concrete Research* No. 22, is only strictly applicable to concrete of maturities greater than 1267° F h (1 day at 64° F).

The tests quoted did not include any on concrete at a younger stage. I am now completing tests on concretes at very small maturities and hope to publish these within a few months. There are indications that the linear relationship between strength and maturity cannot be produced backwards to lower maturities, there being a change of slope at approximately 1000° F h. The law, as stated by the authors, is of course only applicable to curing at temperatures below 100° F and humidities greater than 80 per cent. There is a change in chemical reaction at the higher temperatures which alters the shape of the strength/maturity graph; work on this problem is proceeding.

Your faithfully,
J. M. PLOWMAN.

Faculty of Engineering,
King's College, University of London,
London, W.C.2.
24 March, 1958.

ANODE AND POSITIVE ARE NOT SYNONYMOUS

SIR, I write to draw attention to a very common error in the use of electrical terminology. To put it in the form of an example: if the average student or engineer is asked to state which terminal of a dry cell is the anode about half pick the positive, which is *incorrect*. Although this is of little moment in itself it is important that about half the current text-books on electricity fall into the same blunder of treating " anode " as a more modern and fashionable alternative to " positive." This does scant justice to Faraday who coined the word to avoid just that pitfall.

Faraday was too efficient a scientist to duplicate terms; he was interested in the chemical effects accompanying the passage of a current through an electrolyte, and to be able to state his findings without ambiguity he defined the " anode " as the electrode at which the current enters the electrolyte, and the " cathode " that at which it leaves. In the case of a current forced through an electrolytic cell by an external source of e.m.f., as in Fig. 1, the positive terminal of this source will be joined to the anode.

But if the current is forced through an external circuit by an e.m.f. generated chemically within the cell itself, as in the simple cell shown in Fig. 2, the current in the external circuit will flow from copper to zinc, and the copper will be termed the positive terminal of the cell. As the current flows from zinc to copper within the cell the zinc will be the anode. Thus the plate with the negative terminal is the anode, and the same reasoning applies to all primary cells—*the anode is the negative pole*. In a secondary cell on discharge the same applies; but on charge, when the current is forced from positive to negative within the cell by a superior external e.m.f., the positive is the anode. We now see Faraday's reason for introducing the term anode. The chemical reactions within a cell are tied unambiguously to the terms anode and cathode, whereas their relationship to positive and negative depends on whether the cell is the source of e.m.f. or not, and in the case of a secondary cell, whether it is on charge or discharge.

When I have discussed the above matters with interested parties (including the writer of a text-book) I have received two sorts of answers; one amounts to—" Faraday is long dead, let us

Continuing Letters to the Editor

be consistent and *make* anode mean positive." But this, of course, won't work as too many other terms are involved. For instance the "cation" is naturally the ion which moves to the cathode, and Heaven forbid that the H^+ which is the cation during the electrolysis of acidulated water should become the anion in the simple cell just because we misname the copper as the anode. The second rejoinder, that few educated people make the error, is unfortunately not true. In four current text-books chosen at random from our public library, one only uses the term correctly; one has a correctly labelled diagram of a simple cell and then goes wrong in the text; and two are completely in error.

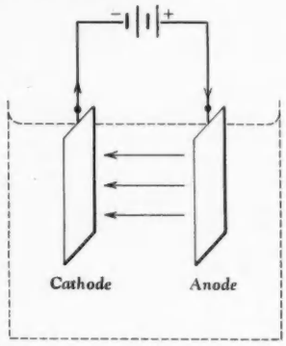


Fig. 1

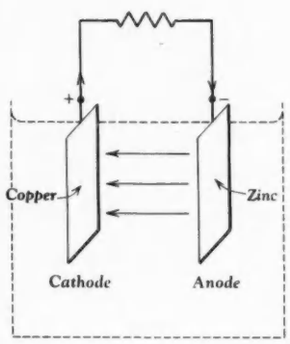


Fig. 2

Perhaps the whole discussion may sound too trivial, but I have always contended that text-books must be infallible to command the respect of students.

Yours sincerely,
G. H. C. NICHOLLS.

411 Barkers Road,
Kew, Victoria,
Australia.
19 March, 1958.

CORIOLIS ACCELERATION

SIR, Many teachers of Theory of Machines will have found that students often have great difficulty in understanding the Coriolis acceleration component. Text-books give proofs, graphical or analytical, based on kinematic principles, and while these are logical and correct, students do not always readily appreciate their significance.

The following proof, based on the relationship between torque and angular momentum, offers an alternative or supplementary approach.

A particle P, of mass m, slides on a light rod OR, which rotates about a fixed centre O.

Let the length OP, at any instant, be r.

Then radial velocity of P relative to OR $= v_s = \frac{dr}{dt}$. Moment of inertia of particle, about axis through O, $= I_o = m r^2$.

$$\text{Torque required} = \frac{d}{dt}(I_o \omega)$$

$$= \frac{d}{dt}(m r^2 \omega)$$

$$= m\left(r^2 \frac{d\omega}{dt} + 2 \omega r \frac{dr}{dt}\right)$$

$$= m r (r \alpha + 2 \omega v_s) \quad . \quad (1)$$

Let the acceleration of P in the direction perpendicular to OR be f.

Then force required, at P, $= mf$.

Moment of this force about O $= mfr$ (2)

Equating (1) and (2), since the torques must be equal, $f = (r\alpha + 2\omega v_s)$.

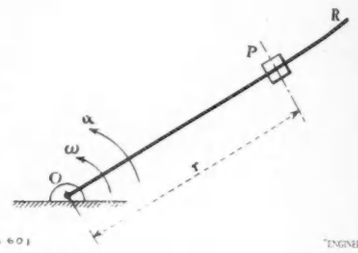
The first term is the usual transverse acceleration, and the second gives the transverse acceleration of the slider relative to the rod, i.e., the Coriolis component.

It will further be seen that the Coriolis acceleration is in the same sense as the angular velocity if v_s be radially outward; if v_s is inward, then $\frac{dr}{dt}$ is negative, and the $2\omega v_s$ term will be negative, i.e., in the opposite sense to the angular velocity.

It is thought that this method may appeal to engineering students who ought to be familiar with the concept of angular momentum, and who have to use the same concept in the study of gyroscopic effects.

Yours faithfully,
J. PIDDUCK.

Mechanical Engineering Department,
Leeds College of Technology,
Leeds, 2.
18 March, 1958.



Obituary

SIR JAMES SWINBURNE, BT., F.R.S.

Just over a month after celebrating his 100th birthday, Sir James Swinburne, the doyen of the engineering world, died on March 30. In the early eighties of last century he was engaged in the development and utilisation of the Swan electric lamp and later worked under Crompton on the design of dynamos and other equipment. Subsequently, he practised as a consulting engineer and was then concerned in the development of phenolic plasters. As recently as 1951, he was the author of *The Mechanism of the Watch*.

James Swinburne, a member of the same family as the poet, was born in Inverness on 28 February, 1858. He was educated at Clifton College and served an engineering apprenticeship at a railway works and with Black, Hawthorn and Company at Gateshead. Surprisingly, considering his subsequent career, he was then engaged for a time as a draughtsman with the South Shields Gas Company and in 1881 was first in the City and Guilds examination in gas manufacture. In the same year he joined J. W. Swan and Company in Newcastle and was employed by them in establishing factories in Antwerp and Paris. Later he went to America to engage in a similar activity for the Brush Company. During this period he made the important suggestion that squirted viscose could be used for the manufacture of the filaments and developed a process for the production of viscose silk from pyroxylin.

On his return to this country he served for a time as manager of the incandescent-lamp department of the Hammond Company and was responsible for the introduction of the butt joint between the filament and the platinum leading-in wires, as well as for more than one design of mercury vacuum pump. Swinburne made the first self-acting compound constant-potential dynamo and also introduced stranded conductors for armature circuits and the system of tunnel winding.

His interest in electrical machinery and instruments continued after he joined Crompton and Company as scientific manager in 1886, a position he occupied until 1894 when he began practising as a consulting engineer. During this period he developed the compound-wound dynamo and did a great deal of pioneer work in connection with the design of electrical measuring instruments. Among these, mention may be made of voltmeters, ammeters and a Wheatstone bridge which were compensated for temperature changes.

He was, as has been said, one of the earliest workers in this country with the materials that have now come to be known as plastics. In the early years of the century he was shown a piece of resin by an Austrian chemist, which had been produced by the reaction of phenol on formaldehyde. He at once recognised its possibilities and in 1904 formed the Fireproof Celluloid Syndicate to investigate them. After two years of research he attempted to register his invention only to find that a similar process leading to what is now Bakelite had been discovered by a Belgian—Dr. L. H. Baekeland (1863-1944)—working in the United States.

Swinburne therefore directed his activities into another channel and, as a result, obtained a liquid which set hard and clear. When asked what it was he replied "I don't know, but it's damned hard." This characteristic remark may have suggested the name of the company he formed in 1910 to market the liquid—the Damard Lacquer Company. In 1927 this company with two others was merged into Bakelite Limited, a concern which has since played a leading part in the development of many types of plastics, and of which Swinburne was chairman until 1953.

In 1934 Swinburne succeeded a distant cousin in a baronetcy, which had been created in 1660. He was elected a Fellow of the Royal Society in 1906; and had been a Member of the Institution of Civil Engineers since 1894. His connection with the Institution of Electrical Engineers began in 1885 when he became a Member. After serving on the Council and as vice-president he was elected President in 1902, and at the time of his death was by far the oldest survivor of those who had occupied this position. In his early days he was the author of a book on *Electrical Units and Electrical Measurement* and was a frequent contributor to the proceedings of scientific societies and to the technical Press.

Plant and Equipment

INDUCTION MELTING STEEL AT MAINS FREQUENCY

The mains-frequency coreless induction furnace has several advantages over the high-frequency type; in particular the capital, operating and maintenance costs are lower, and the installation occupies less space. Numerous mains-frequency coreless furnaces have been built and installed in various parts of the world for melting non-ferrous metals and alloys and for cast iron. The first furnace of this type to be used for cast iron in this country was built by Birlec, Limited, Tyburn Road, Erdington, Birmingham, 24, last year. It was described in ENGINEERING, for 29 March, 1957, page 406.

One of the features of the mains-frequency furnace is that the 50 cycle current induces a vigorous stirring action in the molten metal bath, so ensuring that the whole of the metal is of uniform temperature and analysis. This has obvious advantages in most cases, but at one time it was thought that vigorous stirring might be responsible for an increase in non-metallic inclusions if the furnace were to be used for the production of high-grade alloy steel. There were also other possible theoretical difficulties, but experience gained with a mains-frequency coreless induction furnace on alloy steel production has proved that none of the troubles forecast was insuperable, and that some of the features of the furnace which might have seemed undesirable are quite the reverse.

Believed to be the first mains-frequency coreless induction furnace in the world for regular production of alloy steels, the 1½ ton unit built by Birlec, Limited, for the Inca Steel Company, Limited, Forncett Street, Sheffield, 4, has now been in use for some months, and has proved entirely satisfactory. Already more than £80,000 worth of high-speed steels alone has been produced in the furnace and the ingots and finished bars made for use by Inca Steel and their parent company, the C. R. Denton Steel and Tool Company, Limited, have met all the required quality specifications without difficulty.

To the increasing range of uses for the mains-frequency coreless induction furnace is now added the production of high-speed steel. This Birlec furnace at Inca Steel, Sheffield, has a capacity of 1½ tons.

The furnace, which has a maximum power input of 450 kW, giving an output of up to about ½ ton per hour of ingots, is very simply arranged from the operational viewpoint. Mounted flush with a working platform about 4 ft above the shop floor, it is hydraulically tilted for pouring by means of a self-contained hydraulic unit controlled from a desk at the front of the platform. From this point the operator has a clear view of the progress of pouring. The main instrument and control panel is at the rear of the working platform, and behind this panel is the substation housing the complete electrical equipment. Flexible power input control enables the metal temperature to be adjusted closely.

As with other furnaces of its type, charging is carried out from platform level with the aid of an overhead electric travelling crane, small additions of alloying material being made by hand as required. The same crane serves the casting pit, which is immediately in front of the furnace, the ingot moulds being teemed from a bottom pouring ladle.

ROCK DRILLING AND LOADING

A rock drill and pusher leg, and a power loader are among the new equipment introduced by Atlas Copco (Great Britain), Limited, Wembley, Middlesex.

Designed for working in mines or large tunnels where holes from 10 to 90 ft are to be drilled, the " Lion " rock drill has a bore and stroke of 2¾ in, and at the standard air pressure of 85 lb per sq. in gives 2,000 blows per minute, the drill steel rotating at 200 r.p.m. By a slight modification the drill can be operated at 60 lb per sq. in pressure, when the speed and penetration rate are reduced accordingly. At 85 lb, using a 43mm (1·7 in) diameter bit, the average drilling speed in sandstone is 3 ft and in shale 4 to 5 ft per min. The drill weighs 66 lb and is designed to be used with an air pusher leg, though it can be arranged for screw feed or used as a sinker.

All the controls, for the drill and the pusher, are on the back head and the handle, and as the air supply to the pusher is fed through channels from the back head there is no separate hose for the pusher; only two hoses are required, one of 1 in diameter for air and the other a ½ in diameter water connection. One of the two levers on the back head controls the start of the feed, the water flush and the drill piston, and the machine is started in the correct sequence, by this single lever. A second back head lever enables the pusher feed pressure to be adjusted. Retraction of the pusher piston rod is pneumatic, control being by the handle which varies the pusher thrust. The standard drill is equipped with a rotation chuck for 4½ in by ⅞ in hexagon collared-shank steel.

Designed for use with a pusher leg as shown, the Atlas Copco " Lion " rock drill is also adaptable for screw feed or as a sinker.

Safety, quiet operation, and high capacity are special features of the Atlas Copco compressed-air operated loader.

For loading broken rock into mine cars or wagons Atlas Copco have added to their range of loaders a new compressed air model, the LM56. It is intended for use in tunnels 1·8 to 2·5 metres (7 to 8 ft) wide, and with a minimum height of 2·2 metres (7 ft). A modified version of this loader, the LM56H model, is arranged to fill higher cars than the standard machine and needs a minimum working height of 2·4 metres (7 ft 10 in).

Of the rocking or roll-over type, the shovel is mounted on flanged wheels and driven by compressed air. It has a digging capacity of 2,000 kg (4,400 lb) and has demonstrated, in practical tests, that it can deal with 53 to 73 cubic yard per hour, depending on the rock quality. Total air consumption is 5·8 cubic metres (205 cu. ft) per minute.

The controls can all be locked to prevent accidental movements from taking place, and the operator is protected from foot injuries by a rail in front of the wheels which remains even if the outer platform is taken off for an operator who prefers to stand on the floor. A quick-release diaphragm valve enables all the air to be exhausted instantly from the machine to make it safe for service or maintenance work. Special silencers are fitted to the exhaust side of the air controls, and to the bucket and traction air motors, so that the loader is unusually quiet in operation.

Continuing **Plant and Equipment**

DEW POINT METER

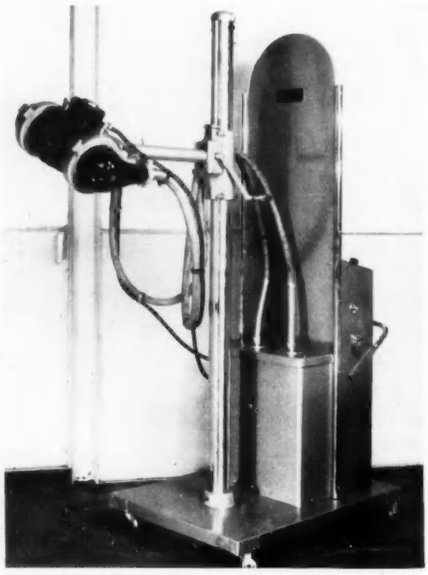
Self-Contained Instrument Working on the Expansion Principle

The Alnor dewpoint meter is a self-contained instrument for precise measurements.

Now on sale in this country by the Electric Resistance Furnace Company, Limited, Netherby, Queens Road, Weybridge, Surrey, is a dew point meter for use with any gases that are not corrosive to brass or copper. Called the Alnor meter it was originally developed by the Illinois Testing Laboratories Incorporated, for work on gases that are relatively dry. It is being made (under licence) by W. F. Casella and Company Limited.

A sample of the gas is drawn in by the hand pump of the instrument and is held in the observation chamber at a pressure slightly above atmospheric. The temperature is noted and the pressure suddenly released by depressing the valve. The same action switches on the lamp which illuminates the chamber to observe if a fog occurs, indicating that the gas has been cooled below the dew point. To ensure that a fog is formed even when there are no dust particles to initiate it, ions for nuclei are produced by some radium foil. The actual dew point can then be read from the slide rule calculator supplied with the instrument.

The instrument can be used for any gas that has a dew point within the range from − 80° F to room temperature and has no need for any external coolant. Precise measurements can be made by semi-skilled personnel and the instrument does not have to be close to the source of the sample while the readings are being taken.



PORTABLE X-RAY EQUIPMENT

Marconi Instruments Limited, St. Albans, have announced an addition to their industrial X-ray range. The new equipment, Type TF1597, is a 110 kVp apparatus, designed for 200 to 250 volts alternating current operation, and basically consists of three units—high tension generator, control unit, and tubehead. The method of mounting these units depends upon individual requirements, and the company's X-ray engineers are prepared to advise and design a suitable arrangement to meet any particular inspection problem. Each of the basic units is portable, which makes the apparatus suitable for a wide range of applications in the field of non-destructive testing.

The 110 kVp generator is oil-immersed in a welded steel tank. It comprises the high tension transformer and an X-ray tube filament transformer. Two 62·5 kVp cable sockets provide the output to the X-ray tube, while the input from the control unit is taken to terminals at one end of the tank. When supplied as a portable unit, the high tension generator is fitted with a pair of carrying handles placed so that the control unit can be rested across the top of the tank when in use, or for storage.

The control unit is housed in a rectangular case with a sloping panel on which are mounted all controls and meters. A stout leather carrying handle is provided to facilitate portability. The hinged top and front panel of the unit may be swung down to gain access to the components and also to the fuses. A synchronous motor-operated self-resetting timer is incorporated, and the customer can make his individual choice from a wide selection of ranges.

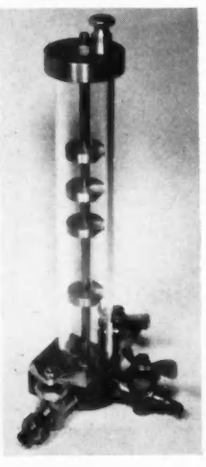
The X-ray insert tube normally supplied can be operated up to 110 kVp, 10 mA, and provision is made for water cooling at the higher ratings, circulation being derived from the normal tap supply. Standard tubehead mountings at present available are: (1) a static tubestand, fitted with four telescopic legs and providing facilities for rotating the tubehead about its short axis. (2) A vertical column tubestand, mounted on a castored base, which is large enough to contain the high tension generator and the control unit; the latter is removable for remote operation, if required. This arrangement is shown in the illustration. (3) A fluoroscopic cabinet, which houses the complete equipment and has a specially constructed control panel built-in. Facilities are also provided for radiography with this arrangement.

ACCURATE FUEL-FLOW GAUGING

A range of fuel gauges for use in the testing of oil and petrol engines has been introduced by Plint and Partners Limited, Blakes Road, Wargrave, Berkshire, a firm specialising in the provision of instructional equipment for mechanical engineering laboratories. These gauges are used in complete test-bed installations, but are supplied separately.

The measuring element of the fuel gauge consists of a cylindrical glass tube in which a central support carries four spacers. These are machined to a knife edge for part of their circumference and are positioned so that a measured volume of fuel is contained between successive spacers. The fuel gauge has the advantage of great sensitivity, since the passage of the fuel surface past each knife edge is clearly defined, takes place very rapidly, and so facilitates accurate measurement of the time to consume the given quantity. Calibration may readily be checked by means of a test cock.

The fuel gauges are supplied in a range of sizes; the smallest, which is illustrated, meters quantities of $\frac{1}{32}$, $\frac{1}{16}$ and $\frac{1}{8}$ pint, or 25, 50 and 100 c.c.



AUTOMOTIVE GEARBOXES

Two new gearboxes have recently been added to the range made by David Brown Industries Limited, Park Works, Huddersfield. The first is a box giving ten speeds and the second is designed for vehicles handling loads of 40 tons and over, being capable of receiving an input torque of 650 lb ft.

The 557A gearbox embodies a two-speed epicyclic unit which has been designed for use in conjunction with the standard five-speed box and so avoids the difficulties of mounting a separate unit. The whole will have alternative sets of ratios in which the top can be either direct or overdrive. In the former the lowest ratio will be 10·9 :1 and in the latter 8·33 : 1; the ratios of the secondary box are 1 : 1 or 1·375 : 1. In each case, modifications to the five-speed box have enabled the torque input to be increased to 480 lb ft. The epicyclic is mounted directly behind the five-unit speed box and is driven by an extension of the main shaft.

The second box is also available as a five- or ten-speed combination by the addition of the epicyclic train. All gears are in constant mesh, with single helical form for the forward speeds and spur gears for the reverse. A full-power take-off can be provided if required and special clutch arrangements can be made to enable the reverse shaft extension to be used for this purpose; by this means rotation in either direction can be obtained. Provision is also made for an electromagnetic speedometer. This box is also available with either direct or overdrive, the lowest ratios (with the epicyclic box engaged) being respectively, 12·25 : 1 and 8·15 : 1.

In Parliament

ROYAL ORDNANCE FACTORIES

A request for information respecting the disposal of redundant Royal Ordnance factories was put forward by Mr. Roy Mason (Labour) in the House of Commons last week. He was particularly concerned in regard to their acquisition by firms who envisaged using the factories for other forms of production, and asked the Minister of Supply to state to what extent there was any liaison between his department and the United Kingdom Atomic Energy Authority, especially in connection with converting a substantial part of this factory space to the production of components for the peaceful and industrial uses of atomic energy.

The Parliamentary Secretary to the Ministry of Supply, Mr. W. J. Taylor, said that, as had been previously announced, the Dalmuir factory was being let to Babcock and Wilcox Limited, as from 1 January next. The factories at Poole and Maltby had been advertised for disposal and the resulting inquiries were now under consideration. The Wigan factory would be advertised shortly. The factories at Swynnerton, Thorp Arch and Irvine presented difficult problems because of their size and nature, and the Minister was not in a position to make any detailed statement regarding them. It was, however, his objective, wherever practicable, to dispose of the factories in such a way as to ensure the continuity of employment.

The Ministry of Supply would be glad at any time to take on additional work for the Atomic Energy Authority, which was within the technical competence of the Ministry, and to adjust its productive capacity accordingly. But the Authority were not tenants of the Ministry and, therefore, the issue of allowing them room for expansion was not one to arise under Mr. Mason's question.

CARGO PREFERENCE SYSTEMS

Problems presented by the growing tendency of some maritime nations to use systems of cargo preferences as a means of fostering or maintaining their national fleets were referred to by Mr. J. V. Woollam (Conservative). He asked the Minister of Transport and Civil Aviation what governments had informed Britain that they were using such arrangements, and what representations had been made to the United States Government about the application of the 50 per cent rule to shipping-cargo movements under the operation of the Export Import Bank of Washington.

Mr. Harold Watkinson said that the British Government were not usually notified of cargo preference arrangements by the countries which operated them. Representations had been made to the Governments of the undermentioned countries, in which such systems were known to exist, namely, Argentina, Brazil, Ceylon, Chile, Colombia, Egypt, India, Poland, Roumania, Spain, Turkey, the United States, and Uruguay. Britain had made clear to the United States Government her opposition to all forms of cargo preference, and especially to those forms extending into the field of normal international trade.

DEVELOPMENT IN AFRICA

The Secretary of State for Foreign Affairs was asked by Colonel Tufton Beamish (Conservative) whether he had received the report made by the Council of Europe study group for the development of Africa and what consideration had been given to suggestions for the establishment of a Bank for African Development and an African Investment Fund.

Mr. Ian Harvey, Joint Under-Secretary of State, said that the study group's report had been received last October. The group was composed of independent experts serving in a purely personal capacity. One member of the group, Mr. Arthur Gaitskell, was from the United Kingdom. As had been stated in Parliament last month, the committee of ministers of the Council of Europe had not yet received any recommendations for consideration by the respective governments, but the report was still being discussed by a committee of the Consultative Assembly. One major problem about the setting up of a development bank and an investment fund was whether there would be any new sources of capital to sustain such institutions. These ideas had not been considered at the recent meeting in Accra. That meeting had been concerned with the inauguration of the new technical assistance scheme known as the Foundation for Mutual Assistance in Africa South of the Sahara, and not with capital investment schemes.

STEAM ENGINES VERSUS DIESELS

Suggestions that the motive power of Aberdeen trawlers should be changed from steam to diesel propulsion were ventilated in a question put to the Secretary of State for Scotland by Mr. Hector Hughes (Labour). Mr. Hughes asked if consideration had been given to the written scheme on fleet re-building submitted by Craig Stores (Aberdeen) Limited, the object of which was to encourage Aberdeen owners of fishing vessels to dispose of their steam trawlers and, with Government assistance, to substitute for them modern diesel vessels. He pointed out that the scheme had the approval of many Aberdeen owners. In reply, Mr. John Maclay said that he had considered the proposals. They would require legislation and he was not satisfied that their advantages would outweigh the difficulties to which they would give rise.

RADIOACTIVE FALLOUT

Asked to state what action was being undertaken to co-ordinate the efforts of the various Government departments to ensure that the public were adequately informed on the best methods of self-protection against radioactive contamination, Dr. Charles Hill, the Chancellor of the Duchy of Lancaster, said that a full investigation into the hazards to health arising from radioactivity had been made by the Medical Research Council in June, 1956. That inquiry had included hazards arising from natural sources, and a number of recommendations put forward by the Council had been published. The Stationery Office had issued two non-technical pamphlets which provided guidance on protection from this cause.

The whole matter was one which required continuing scrutiny, and he would look into the question of bringing these pamphlets up to date —if they required such treatment—and the means of ensuring their wider circulation. At the same time, he told Lieut.-Colonel Marcus Lipton (Labour), it was only fair to get the problem into perspective. When the position was last examined, man-made radiation, as a proportion of natural radiation, amounted to no more than 25 per cent, and that from bomb tests to rather less than 1 per cent.

MONOPOLIES COMMISSION

A request was made to the President of the Board of Trade for information respecting the steps being taken by the Government to carry out the recommendations contained in the report of the Monopolies and Restrictive Practices Commission about the supply of oxygen and dissolved acetylene by the British Oxygen Company, Limited.

Sir David Eccles replied that the Commission's conclusions and recommendations on this matter were summarised in the annual report by the Board of Trade on the operation of the Monopolies and Restrictive Practices Acts, 1948 and 1953, which had been presented to Parliament at the end of February. The Government did not propose to take any action on the majority recommendation that means should be adopted to regulate the level of the company's prices and profits on oxygen and dissolved acetylene. The other matters on which the Commission made recommendations had been the subject of discussions between the Board of Trade and the company, and, at the Board's request, the company had given certain undertakings. A statement giving full details of the agreement that had been reached was published in the issue of the *Board of Trade Journal* for 28 March last.

Nuclear Bearing Aircraft

Mr. George Ward, the Secretary of State for Air, informed Mr. George Wigg (Labour) that, in addition to Valiant and Vulcan aircraft, a substantial number of Canberra aircraft of different marks, which were at present in service with the Royal Air Force, were capable of bearing nuclear weapons. Asked how many squadrons of Canberra B (I) 8 were now in service with the R.A.F., Mr. Ward said that it would not be in the public interest to provide details about the composition of the front line.

N.C.B's £661 Million

Sir Ian Horobin, Parliamentary Secretary to the Ministry of Power, told Mr. C. Osborne (Conservative) that the National Coal Board had invested about £661 million of new capital in their industry during the 11 years from nationalisation to the end of 1957.

Coal Industry's Future

Asked by Mr. Osborne for an estimate of the effect that the development of the atom during the next five years as a cheap source of home-produced fuel would have on the coal industry, Sir Ian Horobin said that, while the contribution of nuclear energy and oil was essential towards meeting Britain's growing need for energy, coal would remain the foundation of this country's fuel economy. Accordingly, it was necessary to have an efficient coal industry producing the grades required in the appropriate quantities and at reasonable prices, and large-scale capital investment would continue to be needed for that purpose. As to employment in the industry, Sir Ian said he had no reason to disagree with the long-term estimates of the National Coal Board, as set out in their programme "Investing in Coal," although, of course, these estimates would have to be kept under review.

Conversions to Oil Burning

An estimate of the total amount spent by industry in recent years in converting plant from burning coal to burning oil, and in the installation of oil-burning equipment in new plant, was asked for by Mr. Ronald Russell (Conservative). He suggested that it would be uneconomic for industry to make any conversions back to coal-burning, as had been put forward in some directions, for the purpose of using small coal. Sir Ian Horobin said that precise figures were not available, but the total amounts spent in the three years 1955 to 1957 in connection with steam-raising plant was about £30 million. Other figures were not available. Without committing himself on the subject of reconversions, Sir Ian said that, very generally, it was not part of the Government's policy to compel private enterprises, or any other enterprise, to do other than to choose the form of fuel which, in their commercial judgment, was the best for their needs.

Trade with Russia and China

A request was made by Mr. K. Zilliacus (Labour) that the Chancellor of the Duchy of Lancaster should co-ordinate and publish information on the nature and extent of Soviet and Chinese proposals for trade with this country, and the extent to which these proposals were being prevented from being fulfilled by cold-war trade embargoes, the demands of defence on industry, and the forthcoming Budget. In a brief answer, Dr. Charles Hill declined to take any such action. He pointed out later that, in so far as trade with the Soviet Union and China was concerned, there had been a substantial increase in this commerce in recent years.

These Fleeting Thoughts

WE PRESENT a report written in a style that is, as far as we know, without precedent in scientific and technical writing. It is the report of a man's thoughts on a topic of great promise—and of great complexity, too. His thoughts have not been arranged into orderly, logical sentences; they remain as random, as inconsequential, as thoughts are, or as near that condition as writing will allow. By thus keeping them fresh and spontaneous, the author communicates his experience.

In January of this year the young American consultant John Diebold, with some of his colleagues, ran a course on automatic data processing in London. Automatic data processing (or ADP) is the modern nervous system of corporate bodies, whether they are companies, institutions, government departments, research establishments or other organisations in which the flow of information and data follows a complicated pattern. With ADP, information flows more smoothly and effectively; computers take over much of the mental work. In addition, the computers are able to produce information which was not previously available. Thus ADP touches the heart of an organisation, it probes the philosophy of the business, and it demands new thinking at the top. But it takes a long time—perhaps several years—for an organisation to examine ADP in relation to its needs because first the organisation itself has to be studied.

Since an examination of ADP by one firm takes such a long time, and has to be tailored to suit the firm, any review of its methods and usefulness can give only the broadest indication of its application to an individual firm. Unless you are predisposed towards ADP you are not likely to recognise its possibilities just by reading a straight-forward account of it. Before the author of this report attended the first day of Diebold's course his conception of ADP was very hazy. At the end of it he felt, rather than argued logically, that ADP had tremendous possibilities. He was unable to prove that it could benefit his firm, still less your's or anyone else's, but he had acquired a strong conviction, as this record reveals.

Here, then, is the report of his thoughts—a " stream of consciousness." He starts with his thoughts while travelling home on the Friday before the course began. A phrase taken from an article Diebold wrote for ENGINEERING, printed here in italics, sets him off.

MISGIVINGS

train people who can adapt to change what about present staff—Nicholson is impossible messes about never gives the right answer only thing to do is move him to another job even promotion might do him good no wouldn't be fair on the others—funny how few suitable for promotion must be sort of natural law—only so many feel they are capable of higher things why can't they all see what I see perhaps it's me—don't give them all equal encouragement—send more on courses where they are stimulated—wonder what it will be like on Monday about 80 chaps going—expect all the big firms just a few go-ahead small and medium firms—

how will Diebold get everyone's interest done it all in the United States—maybe Englishmen not so ready to accept all he says so quickly want proof in black and white that ADP does something—saves money—it's more than that it digs into the business and shows ways of rethinking the whole set-up—chuck out the conventional concepts the accepted means of measuring performance and output go back to the first principles of the business—what are we doing—making a profit to keep in business Drucker said—yes that's all right but what then—what do we do that the others don't do or what can we do better—we make many products—pumps for instance—but more than that we give special service almost consultants help customers in lots of ways nothing to do with pumps—pumps for sewage works and lavatories—funny that time at official opening of sewage works they hadn't got a decent lavatory—he said see that hessian screen over there like the desert rose—was like a village fete gents—wonder if they've got proper lavatory now—what on earth has this got to do with automatic data processing—difficult to see how my firm can use it—anyway got to convince the board even if I'm convinced—still I might do that been doing it for 10 years quite clever at it now trouble is it takes time and we may not have much time don't expect our main competitors are going but you never know what they're up to—oh *ça ne fait rien* great thing is to go at it so hard yourself that they watch us—do they see as many possibilities as I do—bet if I sat down could write hundreds of them got to start with something basic not just making a profit—perhaps seeing always how we can fit in in spite of all the changes around us—eye on the ball—time is the great factor—do things before anyone else not wait to see what someone else does—set the pace and keep them hopping get name for being in the front eventually outside world thinks of us first—get them to that way of thinking and we'll go along under own momentum—

Oh must think about this data processing otherwise I won't get anything out of it on Monday—but even if I see a glimmer how the devil can I explain to the others—they can't see it now think I'm mad anyway but they're wrong I've done too many things for me to be mad—still will they sit up and take notice—they'll be polite I'll have to write a report—that'll be difficult easier than trying to speak to the board have to get one or two on my side perhaps get them on a course so that they can back me up—diplomat that's it—funny not an engineer any longer—yes I am I engineer things so that they think they have thought of it all along doesn't matter if I really thought of it great thing is get things done—oh get back to data processing—

what is it to me—you've got to measure money and output and staff and materials and competitors and the market and see how we're doing—yes but something more perhaps I'll only know when we've actually got the system introduced—operational research does it—fit in with that same sort of thing mathematicians psychologists physicists special chaps ought to get few with previous experience otherwise make a hash of it and finish it with the board put a stopper on it for years—take some of the directors to some other firm where they've got it but somebody will say yes but they're different—Diebold's got the answer to that but perhaps there is no hope of it in my firm maybe just a crazy idea of mine because I like dabbling in the newest techniques—but I'll have to see—no good not trying—somebody else will and then we'll be in the soup—could I go somewhere else but don't want to—so much to do here taken me 10 years to find out—now tell the younger ones see if they can go further know they can—education—that's what Diebold said training the young ones and the ones in the firm already so I'll have to go and find out how to bring the others in with me not just how data processing fits in for us—

can't do that by myself anyway talk to Smith he's the electronic bloke he's young he should have come with me on Monday wonder if I could get him later in the week—no just have to plough through it myself—automation—pity about that word being ruined by the trade unions and the Press—trouble is you can't say what it is properly so that everyone can understand—suppose if all firms went in for it together we'd have hellish unemployment—they won't no fear of that just a few to start—country can stand that the ones that do won't have unemployment because they are go-ahead in everything—but firms who don't might feel the draught they'll lose business—men thrown out of work—God—we've forgotten that—hunger strikes—Prince of Wales's comment—Tustin's book—do the Treasury know it—do they work it—Bank of England—is it all big business professional economists can they affect national decisions or do they get overlaid by events and powers—no—no Government can afford it but what about America and the rest of the world if they muck about might upset our apple cart—powerless—automatic data processing that's it in the Government giving political decisions but will we ever have all the facts—don't see why not—then have to do it in my firm—if *we* can't do it how the hell can I expect Government to do it for the nation—go on Monday and come out seeing clearly though not in detail go back and think how I'm going to start the others—

why have we stopped—must be the junction by now—

Convince Me

The course opened on the following Monday morning. That evening he mused on the day's happenings and considered his first serious impressions of ADP:—

POSSIBILITIES

—was first to arrive at hotel—talk to English delegate—American comes up offers coffee to make us comfortable stacks of books on tables wine glasses water jugs delegates from well-known firms Cooperative Wholesale Society shipbuilder London Midland Region accountants secretaries managing directors engineers research types some oldish ones mostly youngish assemble in room—

young American with crew cut writes three names on blackboard—

DOUGLAS AXSMITH
ALF BERTIL GRECO
HERBERT T. GLANTZ

—talks about John Diebold and Associates—how did he start he's only 31—very impressive set-up —1,000 computers in the States and they've made lots of mistakes some firms pulled out of it it didn't pay—firm that spent two years studying computers put one in to work 20 hours every 24 then found it took over 30 hours had to start again and took another year and another machine—British firms can benefit—firms in Europe Israel India Australia will they understand American will they have enough technical bods to deal with this very very fundamental change—very very fundamental change—got to take new look not leave it all to committees—

top executive on golf course talks to friend about computers goes back to office calls his department heads why the hell haven't we got a computer we can afford one go away and order one—other executive who says we've formed an electronics committee we've formed an electronics committee we've formed an electronics committee we've formed an electronics committee—like a cracked record—it's a parrot cry they think that solves the problem if only they knew it's biggest fundamental change since division of labour no good starting with ironmongery—computers—got to start with systems analysis get to whole basis of organisation spend a few years but don't mess about so long that you never get anywhere top man must ask the simple obvious questions to catch the wise guys who are working it out they get so wrapped up in the mathematics of it they may give daftest answers—

Diebold's boys won't give you tailor made set-up you've got to work it out for yourself with their guidance that means we've got to train our chaps for heaven's sake beware of experts who have switched around so much on computer work that they've never stayed long enough anywhere to do any good—no I must go back at end of week and put wet towel round my head to see best way to get everybody to come in on this—trade unions mustn't be afraid actually no cause for them to be afraid ADP not meant to save labour it gives something vastly more important more effective control of the business production integrates the whole business even controls a lot of branch factories but what about our firm where do I start—

perhaps it will be clearer when I've listened to some of these lectures will they mind if I keep asking questions which are significant only to me what about the other fellows here mustn't stick my neck out too much would Diebold help us after the course expect the fee would be steep will the board approve when they don't really understand it perhaps I should not tell them too much about the snags—still the so-and-soes will have to buckle down to it like me and understand enough of it or else nobody will be able to do anything to get started—Diebold said odd thing that managers willing to say they don't understand electronics so leave it to the electronics bloke but the electronics bloke thinks management is like shelling peas then when he comes up against it he gets a shock—

so we come back to committee to try and get understanding yes that's what American said but you have to get real work done by people who know what they're doing then they can keep in touch through committee but you mustn't think you're just mechanising office procedures—you'd waste a packet that way —you've got to dig right down into whole philosophy of organisation because its very very fundamental change—he kept saying that—yet here he is talking about it and he's only 31 what was I doing at his age could I have done this— I was just about coming out of the Army rather unpictured he was finishing his education but in 10 or 12 years all this has happened—in cycles of 5 years he said—we've got to get used to idea that change is happening at ever-increasing rate we've got to start now or we'll never catch up on the firms who start first if you once miss the boat you'll have a colossal job—

now's the time when computers in U.K. are just starting to be used for commercial applications—up till now they've been on aircraft jobs mathematics research they started in America 2 or 3 years ago to go into commercial applications—that Englishman from steel firm said it's got to come—he was not going to lag behind should we start with a small computer or a medium one—fat-head you mustn't ask those sort of questions you must wait until you've done systems analysis ironmongery will come all in good time—still like idea of hiring one for a few hours just to try our scheme out by Jove that'll shake boys in other departments—

we'll have to get cooperation from start can we afford time people sitting on committees and studying for hours and weeks and months and years still it's a sort of gigantic capital investment not so much of machines but of best brains in firm from top men to some of back-room boys— what about other schemes we've got on the go can those go on just same or should we suspend them until we get this started no I think first thing is have preliminary study quickly as possible to reach big decision is it worth going into automatic data processing at all we'll probably have to reach that decision on incomplete data still that may be best way to get round board—

Diebold said commonest failure in America was firms consistently underestimated time money managerial ability required it's very very fundamental we mustn't get too tied to one system or one make of computer before we really know what we're doing—pseudo-scientific involvement in the sales talk he said—that's why I'm sure we've got to do all spade work ourselves —give it to operating executives he said—thank heaven we've been training deputies in the firm—that V.I.P. was right you've got to allow deputies to push you out of your job otherwise you won't be able to do all these things—even first preliminary analysis will reveal some improvements to be done without computers we must be careful of step-by-step approach otherwise we'll find ourselves in few years' time saddled with expensive machines that are not suitable for new and better solution to the problems—

Diebold said about two-thirds of 1,000 firms in the States expressed disappointment at results of automatic data processing—lot of them bought computers without adequate consideration of what was involved don't think British firms will make same mistake but may take longer to make up their minds still that's better than going in for computers only to mechanise existing processes and procedures— Diebold said it's not worth it if that's all you expect to do—some Americans have spent hundreds of thousands of dollars on machines and then put in charge people who have only had 8 or 10 weeks experience at computer school—you wouldn't do that with any other equipment—costs thousands and thousands of pounds—hellish complicated business—blowed if I see if it could do us any good—so many factors don't know where to begin can you really rationalise a business sufficiently to be able to bring in ADP what about staff training getting right people don't seem to have many of right kind now perhaps they'll change when we get cracking—oh I've had enough for one day— haven't looked at the paper where the devil is it—

The course lasted five days, from Monday to Friday, with lectures, formal and informal discussions, and a set of detailed manuals which the delegates could take away with them to help them in applying ADP to their own firms.

AND HOPES

Thank God we've come to the end of the week —must have a bath and a jolly good dinner— get into bed and try to clear thoughts—make some notes—see how it all fits in—put down the first ideas for the firm—can do that—it'll make sense to me—that's no good—got to make sense to the others—wonder how things have gone on —shouldn't have phoned Nicholson—sounded as though didn't trust him to carry on—he's not bad really—give him the chance and perhaps he can carry it off—he'll have to if I take up ADP for the firm—at least two years work—

Oh forget the bath—sit down now—get my notebook—light a cig—bloody awful light in this expensive hotel—why don't they try staying in the hotel themselves—they'd soon see what's wrong—perhaps customers say the same about the firm—they won't when we've got going with

Continuing These Fleeting Thoughts

ADP—they'll think it's a miracle—my what I could do for the old firm now—it's fantastic—management we've been playing at it—we've been doodling around—haven't even asked the right questions—just didn't know what was happening—only reason we've made a profit is that all the others have been just as much in the dark—now we see through a glass—darkly—then face to face—is that sacrilegious—not if I mean it sincerely—it's true we are getting more and more god-like—getting less and less like the animals—more and more controlled by our intellects—how far will we go—we're still wild half the time—but the other half we're supermen—it's frightening—does anybody know where we're going—will we just go on getting more and more control over our minds and ourselves and our environment—or will there be a big bust-up—

Oh come down to earth—where are Diebold's manuals—I'll try just flicking through my notes and the marks in the manuals—skim off the cream of my thoughts—put them in some shape—then let my mind rest—fallow—for the week-end—the good old subconscious will work on it when I'm not thinking—on Monday report back and then go into hiding if they'll let me—put everything I've got into the written report—it must persuade them—compel them with the sheer force of argument—open their eyes—put them in a spot where they can't turn it down without appearing to be fools—see the report is read by enough staff and directors to make it a burning issue—it'll take time but they wont be able to ignore it—I'll start a sort of tidal wave through the firm—nobody will stop it—anybody who tries will have to be dealt with—according to his position and influence—just get three or four at the top—get them on my side and the rest'll have to follow—still I mustn't steam-roller them—they've got to cooperate or it's no good—thank God the M.D. is behind me—he's sold on it—

this is the one—" Managing the ADP Program "—Diebold's boys certainly know how to turn it out—" sound psychological atmosphere for the study group "—that's going to be first problem—" management level people are the only persons within the company who have the experience necessary to estimate the value of these intangible benefits "—that's the rub—you can't say let's get a bunch of experts in and let them work it out for us—somehow we've all got to get involved in it—" there are few things as embarrassing as exceeding the budgeted cost of a project by 1,000 per cent; particularly when there are no concrete results in terms of savings which can be pointed to with pride "—yes that would put the kibosh on it—

" the most efficient use of ADP equipment and techniques requires that the business data processing functions be approached as a total problem without being bound by the existing departmentalisation of functions "—that's wonderful—get right outside the business—forget the forms we use—the returns—the departments—the lot—and rethink it—terrific—what a task—it may be five years before it pays dividends but by the hokey fiddle it'll shake us—" for the first time in the company's history, a completely fresh appraisal—

a study team has to write up a description of each job—" a brief analysis of what that job does not how the job is done "—you build up a picture of the organisation that is elemental—without reference to how things happen to be done at present—" the systems analyst is concerned with asking questions of fact not opinion" fascinating the way they dig out of people just exactly what is going on—sort of cross-examination in a friendly way—then you draw up the firm's procedure flow chart and the decision flow chart—expect we would find certain decisions are reached without anyone being aware—just because nobody has thought to ask why do we do this and not that—maybe some of the top executives are being paid to reach decisions which could be reached by a lower paid man—give the top man time to study questions which they hardly know exist—" if there are already good written procedures for each job the study work can be much easier"—but you've got to check that they're doing what the book says they should do—I bet they're not half the time—but it's the book's fault not theirs—ah here's this note I made—when you've introduced ADP how can you be sure you can change the set-up as easily as we can now without upsetting the whole thing—that's a tricky one—we spend 3 or 4 years studying systems and bringing in ADP—tremendous upheaval however you do it—then when you've got the thing going nicely along comes the board and gives us a new policy—ghastly thought—

the big moment—" re-thinking the system "—real creative work that'll be—hope I'm in on it—it'll open our eyes—for the first time we'll know what we want—exactly—comprehensively—the whole picture—like a whacking great game of chess—all the moves—the values of all the men—" re-thinking the system consists of determining the types of information really needed for effective management and operation, estimating the costs of obtaining the various levels of data and matching the value of having these data with the cost of obtaining them "—makes you wonder how we've muddled through all these years—we're doing quite well but when we get this we'll be absolutely on top—nobody will be able to touch us—

not much good going further than that now—it'll be a year or two before we get there—question is do I think now that ADP is thing for us—is it too early to ask that—*sure* it's the thing—help us in lots of things we worry about—simplification standardisation how far to go with special designs—control over costs—best proportion of expenditure on different things—watching customers and competitors—beating them with deliveries—how much bought-out stuff to go in for—how often produce new designs—best compromise of quality and price in relation to market and competitors—get rid of fear of missing opportunities—running out of stock—depend less on memory and experience of chaps who may die—give senior staff more time to think about things that matter—get around and talk and see what's going on in outside world have feedback through experience to improve products—make managers manage—all executives are managers though they don't know it—they all have to make decisions on questions that can't be measured ADP will ensure they have to think only about questions that only the human computer can decide—we'll get a kind of super strategy operating—

funny thing—I can't *prove* ADP is right thing for our firm but I know now—absolutely know it is—can the subconscious work it all out without telling the conscious—the mind itself is like a super computer—takes sort of several layers of thought at the same time and puts them all together—not just thought but past experience and knowledge and all you've learnt in the past few days and the habits of thinking I learnt at school and developed all these years—the analytical ways of the mind and the way of synthesising—darn good maths master Wilkins—and Morgan for English the way he got us to think for ourselves—that was when learning was fun—maybe all this builds the mind up into this fantastic computing machine so that it gives you the answer without giving you the reasons and then with ADP you've got to spend two or three years actually working out the logical reasons that you can put over to the board—of course that's what we mean by a manager's hunch and the best managers are those whose minds are always working like that and they are always coming out with the ideas that make things tick—it's awful I mean it literally fills you with awe to think of what the mind could do if it and an electronic computer were properly geared together and if we got several minds all dovetailed in together with a computer digesting and feeding information then the whole system would be beyond anything we can imagine now—no man can say he does it alone and consciously—you've got to stand to one side and say it's the Creator or whatever god you can imagine and accept—and say it's he who is doing this fantastic computation using your mind for the purpose and then if you do that you're suddenly in the frame of mind where you know you can do anything because it's not your mind at all it's his working through yours—

now I know—through a glass darkly yes but that doesn't matter I know we can apply ADP—the difficulties of convincing the others will vanish slowly if I really put my mind to it because my mind will do some immensely complicated searching and computing and will put the words into my mouth when I speak to the directors and the others—it'll take a long time there's no short cut—

my I feel good—kind o' proud—no not pride that would reduce the power of my mind to something hum-drum—you've got to retain humility because while you can keep that this mysterious miraculous force can work through you—

sleep and the mind will work

END

Brief Guide to United Kingdom Sources of Information and Advice on ADP

CONSULTANTS

Associated Industrial Consultants Ltd. (Mr. N. Pleming, Managing Director), Bush House, Aldwych, London, W.C.2.
Computer Programming Service Ltd. (Mr. J. P. Mandeville), 23 Bedford Square, London, W.C.1.
Personnel Administration Ltd. (Mr. T. P. Bowman), 2 Albert Gate, Knightsbridge, London, S.W.1.
Production-Engineering Ltd., 12 Grosvenor Place, London, S.W.1.
Urwick, Orr and Partners, Ltd. (Mr. J. P. Harper), 29 Hertford Street, London, W.1.
In addition, there are professional firms of practising chartered accountants who have specialised in the planning and application of computers to managerial and business problems. Professional etiquette does not permit us to include their names in the above list.

SOCIETIES

British Computer Society, 29 Bury Street, St. James's, London, S.W.1.
British Institute of Management, 80 Fetter Lane, London, E.C.4.
Institute of Cost and Works Accountants, 63 Portland Place, London, W.1.
Office Management Association, 58 Victoria Street, London, S.W.1.

MAKERS AND SUPPLIERS OF COMPUTERS

British Tabulating Machine Co. Ltd. (Mr. C. D. C. Dickens, Home Sales Manager), 17 Park Lane, London, W.1.
Burroughs Adding Machine Ltd. (Mr. A. O. Harries, Product Promotion Manager), 356 Oxford Street, London, W.1.
E.M.I. Electronics Ltd., Hayes, Middlesex.
English Electric Co. Ltd., Marconi House, Strand, London, W.C.2.
Ferranti Ltd., 21 Portland Place, London, W.1.
IBM United Kingdom Ltd. (Mr. N. Jonas, Manager, Data Processing Department), 101 Wigmore Street, London, W.1.
Leo Computers Ltd. (Mr. J. Randell), Elms House, Brook Green, London, W.6.
Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester 17.
National Cash Register Co. Ltd. (Manager, Computer Group), 206-216 Marylebone Road, London, N.W.1. (This firm also markets ADP equipment made by Elliott Brothers (London) Ltd.)
Powers-Samas Accounting Machines (Sales) Ltd., Holborn Bars, London, E.C.1.
Remington Rand Ltd. (The Manager, Univac Computer Division), 26 High Street, Kensington, London, W.8.
Standard Telephones and Cables Ltd. (Mr. F. G. Filby), Corporation Road, Newport, Monmouthshire.

REFERENCE

Diebold, J., " Go Into Training for Computers," ENGRG., 10 Jan. '58, pp. 38-40.

Companies in the News

Asia's Problems

The economic position of Far Eastern countries is bad and deteriorating. The influence of the West is weakening, due partly to the lack of appeal of their politics, but mainly to a failure to appreciate the economic difficulties of the countries concerned. The politically moderate in India, Malaya, Pakistan, Ceylon and elsewhere rely on a twin policy of exporting primary products and pushing ahead with industrialisation. The prices of primary products have fallen so much in recent months because of the United States recession that everywhere machinery import programmes are having to be cut, industrialisation schemes delayed and imports of consumer goods ruthlessly slashed. Out of all this emerges a set of conditions, political and economic, where the countries who will wield most influence on the East will be those who do not hesitate to export on long-term credit, invest heavily in industrial developments, train and educate a body of artisans and technologists from the countries concerned to enable industrialisation to proceed and primary production methods to improve.

The chairmen of three banking organisations with unrivalled experience of the East have recently reviewed the whole position in their annual statements. Mr. V. A. Grantham, chairman of the Chartered Bank, commented as follows on India's much publicised shortage of foreign exchange, particularly Sterling: " . . . it is clear that her problem is common to other Asian countries. In nearly all of them there has been the urge towards rapid industrialisation which has caused excessive imports of capital goods and imposed further strains upon dwindling resources of foreign exchange." Sir Kenneth W. Mealing, chairman of the Mercantile Bank Limited, placed great emphasis on the success of the Congress party in the Indian general elections and made the same point as Mr. Grantham concerning the shortage of currency. "There has," he said, " been a further measure of inflation, inevitable in the circumstances, and, in the second half of the year, a good deal of industrial unrest."

The third bank, the Hongkong and Shanghai Banking Corporation, gave a most detailed review of conditions in each of the Asian countries. These are so critical in India that the import of capital goods is being reduced to permit imports of raw materials needed by existing industries. In support of this policy, the Bank's chairman, Mr. C. Blaker, comments that " there will be no overall benefits to the economy if existing industries are forced to curtail production." His conclusions form a most striking message to the West: cut out fluctuations in demand for raw materials and agricultural commodities, lend to support development programmes, sell capital goods in such a way that they can be paid for out of earnings (or savings). Asia's needs are such that an economic vacuum has been formed. Both Japan and Russia are aware of this and ready to take full advantage of it.

Nickel Surplus

Few would have expected even as short a time ago as last year that International Nickel Company of Canada, the world's largest producer of nickel, would be cutting production by 10 per cent " because of the present surplus of metal." The company's chairman, Mr. John F. Thompson, notes in his report that during the latter part of 1957, the supply of nickel available for civilian consumption exceeded it for the first time since the Korean War began in 1950 and that the use of nickel " can once again be governed exclusively by technical and economic considerations."

This reversal of fortunes came two years before world supply was expected to catch up with demand and it is clear that this is the result almost entirely of United States influences. The drop in demand from American industry, particularly for steel making, and the end of stockpiling amounted to far more than could be compensated by a good demand elsewhere in the world. The disposal of strategic stocks by the British Government merely increased the size of the company's problem.

The chairman and president of the company see no early recovery of demand, either for nickel or copper (the low price of which was mainly responsible for the 10 per cent fall in the company's profits.) Stocks, they said, were accumulating in their hands as well as those of others and far more will be available in 1958 than is required. " Civilian industry, accustomed for eight years to thinking in terms of inadequate supplies of nickel, has not had sufficient time to adjust itself to conditions of plentiful supply." But they have confidence in the future and describe the long-term outlook for nickel as " excellent."

Hard-to-Please Airlines

Airlines have to operate in a highly competitive world, with small margins for error, and working " close to the edge of their knowledge." Expanding on these basic facts of airline life, the chief engineer of British European Airways, Mr. B. S. Shenstone, has explained " Why Airlines are Hard to Please " in the thirteenth British Commonwealth lecture, given before the Royal Aeronautical Society in London.

Competition with other airlines demands constant striving; unless economy is linked with the most modern speed and the most modern comfort, an airline will soon lose its traffic. No airline can ever secure more than a short-term advantage; no airline can afford to have special aircraft built solely for its own requirements—the price of aeroplanes made in limited numbers is far too high. This continual fight for supremacy leads to small profit margins.

Because operations are planned and seats are sold in advance, an airline demands that a new aircraft be delivered on time and according to specification—a demand that the manufacturer of military aircraft is unused to facing. An airline " dare not experiment too much with manufacturers who cannot be fully depended upon to deliver the goods in a usable condition." Probably the only way a manufacturer can enter the first-line civil aircraft market is by working up from feeder-line aircraft, thereby developing " the attitude of mind, the equipment and the facilities needed by the civil airline operator."

Do the airlines really know what they want? In respect of operating experience, Mr. Shenstone thinks, they do—such things as interior layout and passenger comfort, routine maintenance, and turn-round time. In respect of basic aerodynamic and structural design, they will usually bow to the greater experience of aircraft manufacturers. Airlines also think they know what they don't want, on the basis of past troubles, but this may be a dangerous philosophy: often, intensive development of a troublesome system may prove to be a better solution than a radical change; and " the customer has a perfect right to ask for the earth, but the supplier, if he is wise, will not necessarily let him have it."

Operations in United States Steel

The review of the activities of the United States Steel Corporation by their chairman, Mr. Roger M. Blough, contains useful information on steel making in the United States during 1957, a year when the industry was operating close to full capacity. The figures are astronomical: sales amounted to 4,414 million dol, averaging 16,682 dol for each employee, at an average of 8·81 dol per man-hour; profits 419·4 million dol, or 9·5 per cent of sales. Production 33·7 million short tons of ingots and castings, or 85·2 per cent of capacity. Operations on this scale are hard to conceive in terms of British practice and capacity. The instructive message in this is the possibility, even likelihood, that if the European Free Trade area comes into being, production of steel on this kind of scale will result. Steelmakers will increasingly be concerned with optimum capacities and a great deal of research will be needed to establish them.

U.S. Steel's output in 1957 was a little higher than in 1956 but fell short of the 35·8 million record tonnage produced in 1953. Capacity on 1 January, 1958, was rated at 40·2 million net tons of ingots and castings, which represents 28·6 per cent of the capacity reported for the United States steel industry as a whole. The trend of sales was downward throughout the year, particularly towards the end when users were reducing stocks all over the country. Nonetheless, U.S. Steel spent nearly 515 million dol on additions to and replacements of capacity, compared with 312 million dol in 1956. A further 665 million dol was required to complete all authorised projects, 14 per cent less than at the end of 1956, but still a very large sum—indicative of the confidence the industry retains in its long-term prospects. Concerning the future, Mr. Blough could only say that the economic situation was most serious but that " the basic economic progress of the nation is, however, certain to continue." Whatever the stresses of the moment may be, U.S. Steel appear determined to go on expanding.

Expansion in Instruments

Two of the leading makers of scientific instruments, Negretti and Zambra Limited and Hilger and Watts Limited, have just reported a highly successful year with record turnovers. Mr. G. A. Whipple, chairman of Hilger and Watts, was exceedingly optimistic concerning the current year's results: " The volume of orders received is running at a high level, and all the company's production units should benefit from the intensive efforts now being made to standardise component parts used, to co-ordinate planning between the three main factory units and from many other various means." He had several product developments to report, including excellent progress of their fully automatic spectrographs which he described as " one of the best, and certainly the cheapest, in the world." An instrument developed by the company, a micro-focus X-ray diffraction equipment, made a major contribution to the discovery that D.N.A. (deoxyribo-neucleic acid) is probably the chemical which provides the basis for heredity, which has been called " the biggest biological break-through in the last 50 years."

Hilger and Watts surveying instruments were used by Dr. Fuchs's expedition to guide the expedition and to map its scientific work " at temperatures lower than those for which they had been designed and tested." Seismographs and other recording instruments have been supplied to several countries for research work during the international geophysical year.

Mr. G. A. Negretti, chairman of Negretti and Zambra, announced increases both in turnover and profits, to £1·48 million and £306,000 respectively. Margins have been reduced but, despite this, the company's performance in increasingly competitive conditions was most satisfactory. Mr. Negretti told the meeting of various changes that had been made in organisation and staffing and in improving the co-ordination of activities in their two factories in London and Aylesbury. Mr. Negretti anticipates another successful year, pointing out that the company's productive capacity is greater than ever and that their sales force has never been more active. Such buoyancy on the part of scientific instrument makers is welcome indeed, and an encouraging sign that the recession is not, so far, very deep or very serious.

The Human Element

Angry Young Men

At a conference of the youth section of the Amalgamated Engineering Union last week at Bournemouth there were reports of growing unrest among engineering apprentices about pay. There was stern talk among the 52 delegates about strike action. Speakers harped back to the well-remembered apprentices' strike in 1937 which, not surprisingly, started on the Clyde. It took Mr. W. J. Carron, President of the A.E.U., to instil an element of caution into the proceedings. Delegates however unanimously approved a resolution demanding another approach to employers.

According to age, engineering apprentices are paid between 22½ and 62½ per cent of skilled man's rate. If their claims were met the rate would go up from 52½ to 90 per cent. In these days of full employment, when so many youngsters are attracted to high earnings in unskilled work, there is bound to be a certain amount of pressure from those who train for a skilled job to exact higher rates of pay.

The real trouble is a basic one. Therefore it would be much better for the industry as a whole to face up to the antique nature of much of the apprenticeship system and try to work out something more up to date. In this respect engineering is better off than some skilled trades, but instead of trying continually to adjust traditional apprenticeship methods to modern conditions it would surely be better to accept the fact that in an age of automation and full employment, there is a long-term interest both for employers and the craft unions in speeding up apprentices' training to turn them into qualified skilled men as quickly as possible.

Instruction by Fear

The British Safety Council is to issue next month a new type of horror poster to stress the need for scrapping worn and damaged hand tools. These will be sent to factories throughout the country as part of a vigorous campaign to cut down minor accidents. In a recent report the Council has assessed that injuries caused by unserviceable hand tools work out at about ½ million a year. The Council therefore conclude that the comparatively small number of accidents caused by hand tools as recorded in the Ministry of Labour statistics are misleading and that a very large number of accidents do not get reported.

The motive of the Council in bringing the high casualty rate among users of hand tools is highly commendable. The decision to make an impact by means of horror posters is questionable. Up to a point horror pictures make a constructive impact. Beyond that they generate fear. Two outstanding examples of horror techniques that went astray are the famous picture of a bereaved widow in funereal black with an emaciated face who was intended to illustrate the consequences to dependents of carelessness on the roads. Probably people were more troubled by the thoughts of wasting diseases than traffic accidents. Worse than this was the repeated efforts before the war to further the cause of disarmament by exhibitions of the horrors of war. These created more fear of war than they stimulated any constructive, intelligent interest in international affairs. Horror, as an ingredient of persuasion, should be used in small doses.

Three-Fold Increase

A survey has been made by the Institution of Chemical Engineers into the output of chemical engineers in this country. The results are better than might have been expected. In 1956 this country turned out just under 300 chemical engineers and it is expected that 10 years later, that is by 1966, there is a reasonable prospect of producing 950. Such a figure would be better than a minimum goal for scientists and engineers as a whole given in *Scientific and Engineering Manpower in Great Britain* (H.M.S.O. 1956).

The biggest source of output (as expected) in 1956 was from the universities, which accounted for 62 per cent of the total so far as first degrees are concerned. This percentage is expected to drop to about 55 by 1966, while the output of technical colleges is expected to go up from 20 per cent to 33 per cent of the total. In other words expectation is geared very much to the current expansion in facilities of all kinds at the technical colleges.

The survey draws attention to the shortage of teachers. The increase in output so far (that is, in the first two years of the decade under consideration) has been achieved to a very large extent by improvisation on the part of professors and senior teachers. They point out that one consequence of this may be a risk of a reduction in quality. This is a risk which is bound to arise when the supply of technical manpower is being rapidly increased but it is a possibility which has to be expected.

Sponsored Fellowships

Increasingly engineering companies are investing in higher education to ensure that they receive their share of graduates. The Wilmot Breeden group of companies recently announced their decision to sponsor two fellowships, each worth £1,000 a year, one at the University of Birmingham and the other at Birmingham College of Technology. They have thus ensured that there will always be a Wilmot Breeden Fellow working in association with the University and another with the College. An intimate contact will therefore be maintained. not only with the research work being conducted in these two establishments but also with undergraduates and students who may later join the group.

An interesting aspect of the company's thinking relates to their expressed desire to have on their staff both men from the Universities and men from the Colleges of Technology. The fellowship is therefore open to people trained in both. Another is the feeling that they want to develop closer relations with the academic world in their own city. This is an attitude which, were it more prevalent in engineering circles, could go far to solve not only the problems of the supply of technologists, but the universal one of keeping in touch with basic research. The Universities and Colleges would likewise benefit, for they would become much closer to the realities of manufacturing industry.

Bus Deadlock

The situation which has developed following the Foster tribunal award is one of near-complete deadlock. The London Transport Executive have made it clear to the Transport and General Workers' Union that it can only implement the award by cutting services to a considerable extent, with a possible reduction in the labour force. The busmen themselves disagree with the award because (*a*) the amount awarded to central crews—5 per cent—is not enough, and (*b*) country crews have been left out of the award altogether. These crews have enough voting strength to exert a decisive influence on the Union's attitude, and their resentment at being left out may prove to be the greatest single factor in bringing about a ban on overtime or a strike.

L.T.E. have refused the Unions' request to postpone their 4 per cent cut in bus and trolley-bus services, due to take effect in May and June, until the wage dispute has been settled. The crews fear that the cuts will reduce opportunities for overtime and therefore result in a general fall in their earnings. Mr. Frank Cousins has now taken up the matter personally and asked Sir John Elliot, chairman of the L.T.E., for an immediate meeting. Sir John accepted this suggestion and (as we go to press) the meeting is now likely to take place on the eve of the Easter holidays. Mr. Cousins informed Sir John Elliot of the decision taken by the delegates to ask for plenary powers to take strike action unless an all-round increase of 10*s.* 6*d.* a week is paid to the 50,000 workers concerned. He will doubtless want to postpone any decision until the result of the award of the railway wage tribunal has been published after the holiday.

Shorter Hours

The engineering employers have agreed to meet representatives of the Trade Unions in the industry to discuss the possibility of a shorter working week. An earlier claim for an immediate reduction from 44 to 40 hours was rejected out of hand, but the unions' request for a gradual introduction of a shorter working week may offer a better basis for agreement. The unions propose that the 40 hour week should be introduced over a period of years—two to five years have been mentioned. They are likely to ask for an immediate cut to the 42½ hours which now prevails in the motor industry.

The main obstacle to a quick settlement is likely to be the unions' insistence that the basic weekly rate of pay should be unaltered. This is tantamount to requesting a minimum increase of hourly wages of 3½ per cent, and probably more if more overtime working became necessary. The employers cannot readily accept anything which will lead to a general rise in manufacturing costs at the present time without prejudicing the whole movement towards lower prices. Their ability to resist such demands will be vitally affected by the settlement terms of the wage disputes with the Transport Commission. Any weakening of the Commission's position in these two test cases would make the engineering employers position exceedingly difficult to maintain.

Copy to Mr. Cousins?

The Institution of Professional Civil Servants had an eventful year in 1957. On the national staff side, the gratuity position of temporaries with five or more years' service was improved, a pay increase was obtained for those below surtax level and provincial differentiation on salaries was narrowed.

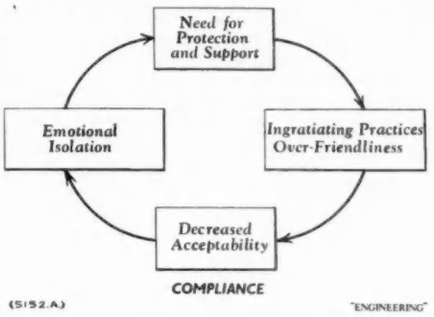
As the report points out, the big issue for 1958 is likely to be redundancy. The defence cuts have already started to have their effect on military establishments and hence on the employment situation for certain branches of the Civil Service. Further, although Mr. Thorneycroft no longer resides at 11 Downing Street, the axe of economy is still poised over the manpower establishment of the Civil Service in general.

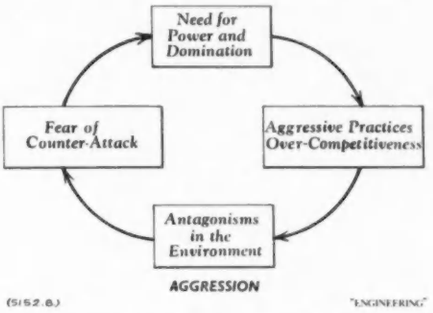
There is much in the problems of the Institution which might bear examination by the Transport and General Workers' Union. A constructive attitude on provincial and London pay differentials and a cautious view on a future which holds more prospects of contraction than expansion—this has a familiar ring for Mr. Cousins this week-end as he thinks over his next move now that the Chairman of the London Transport Executive has agreed to meet him for discussion on the London bus operatives' turn-down of the 8*s.* 6*d.* offer. He might like to read the Institution's opening paragraphs to its annual report while he waits for the results of the arbitration award for his friends the railwaymen.

THREE HUMAN REACTIONS: AGGRESSION, SUBMISSION OR ESCAPE

By Z. M. T. Tarkowski, B.SC.

The previous article compared certain aspects of human behaviour to the activity of an automatically controlled system—an automated factory. It was shown that under certain conditions an emergency state can sustain itself in the absence of genuine danger signals. In such circumstances words and gestures acquire connotations of aggression which were not originally intended, and communication between members of a team is impaired. This has a deleterious effect on efficiency. Now the analogy is carried further and a number of separate modes of response to danger are shown to be liable to give rise to other sets of spurious feed-back circuits and to lead to instability.





As we all know, people react to danger in different ways. Some seek protection, some escape and others hit back. Most of us feel helpless at times and experience a need for support. On occasions we may want to be alone, to keep a safe distance from people and from dangerous things. At other times we may be determined to fight and achieve power and success. Although these three types of reaction are present in almost everyone, many of us are prone to behave in one of these three ways most of the time. Thus, some people are, on the whole, anxious to please—they try to fit in, to subordinate themselves to the group or to some stronger individual. In short, they are *compliant*. Others prefer to stay away, not to fight and not to compete and not to have to fit in. What appeals to them is isolation; they can be called *detached*. Those belonging to the third group distrust their fellows, seek safety through power in an attempt to control the situation. They take an *aggressive* attitude towards life.

Some of us go through all these three attitudes, others swing between any two of them. A third group seems to exhibit permanently only the one form of reaction. The phenomenon is further complicated by the fact that each one of the basic moods can be of several different varieties, so that the fundamental regularities are obscured.

Some people swing violently from one of these moods to another at regular intervals. With others the mood shifts depending on some external circumstance to which the change clearly can be related. A third group go through the changes of outlook in a wholly unpredictable fashion. Even in this category, however, some cyclic regularities and some causal connections can often be found on closer examination.

The compulsiveness of these attitudes and the suddenness of the changes increase markedly at a time of stress. When we feel safe and relaxed we can adopt that attitude which is the most appropriate for the occasion. When the need for a change arises the transition between the three basic attitudes is comparatively smooth and easy. Under conditions of psychological hardship, the compelling force of any one mood overrules a person's better judgement. An attitude is persistently maintained irrespective of the circumstances, or it swings involuntarily, with a disorganising effect on a man's activity.

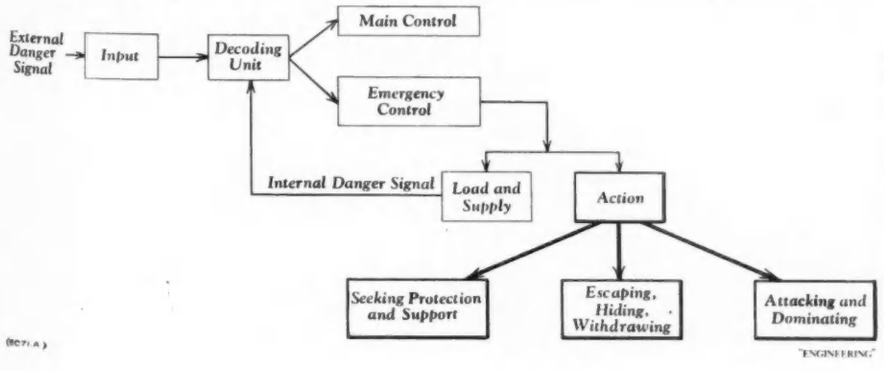
To repeat, some people appear to have permanently adopted only one of these attitudes. There are grounds to suppose, however, that in such cases the other tendencies still remain in force, but that their operation is disguised in various ways. It is, however, possible to ignore this point, for the moment, and to discuss the three sorts of people, the *compliant* type, the *detached* and the *aggressive*, as if they were wholehearted and without other tendencies.

A *compliant* person often feels helpless and wants to lean on others. He puts a great emphasis on affection and loyalty, but always adheres to the strongest party. He feels too weak to be able to support any minority group. His great need is to be wanted, desired, accepted and welcomed. He must be approved of, appreciated, protected, needed, helped and taken care of. He feels other people have similar needs to his own and tends to think of everyone, with perhaps a few exceptions, as being "nice," and a "good chap." He believes everyone to be sincere. As a result he becomes over-appreciative, over-polite, over-grateful, and may exaggerate his generosity and helpfulness to the point of subtly imposing on others. This may be irritating and may make him much less likeable and accepted than he desires to be. Moreover, the vague feeling that he is not altogether welcomed and sought after may create a vicious circle: he so badly wants to please that he may almost resort to bribery. He may even become obsequious or servile which, of course, only makes him less acceptable.

A *detached* man keeps aloof. He does not want to fight or to belong. He usually experiences considerable stress when associating with people. This ordinarily takes the form of embarrassment or shyness and may be conspicuous or it may be hidden behind a façade of somewhat stiff formality or exaggerated brusqueness. Although he may desire to be a good mixer or to achieve success through power and domination, the tension imposed on him by social life and the fear of competition are such that in his actual behaviour he shuns company or the limelight. He may feel excluded and resent this self-imposed isolation, but he prefers to keep at a safe distance. This is likely to lead to a ban on strong feelings or emotional involvement. Also, he may restrict his needs and interests so that nothing and nobody shall become indispensable to him. He dislikes sharing any emotional experience. He abhors being taken for granted and is hypersensitive to any semblance of coercion, influence, obligation or interference. He bitterly resents a reprimand and resists advice even if he agrees with it intellectually. Similarly, although he may see and acknowledge the necessity of undertaking long-term commitments he persistently sabotages and avoids them to maintain a subjective semblance of freedom.

An *aggressive* person assumes that the world is a jungle. He anticipates and prepares for hostility. He distrusts and suspects everyone's intentions and is determined to fight. For him the road to safety lies through power, prestige and possession. When confronted with friendliness he is doubly cautious; to his mind it is a sign of either stupidity or cunning. He is usually inordinately competitive, conceiving life to be an unceasing struggle. In this war of all against all he believes he would be a fool not to be on his guard. He must always be prepared to strike back. He feels he always ought to try to be the absolute master of the situation. This quest for control and domination may involve him in a powerful vicious circle: he is likely to antagonise many people and make serious enemies. Also, he is likely to exaggerate, in his mind, their hostility and anticipate jealousy, even without good reason. To defend himself against these enemies and dangers, whether real, exaggerated, or wholly imagined, he needs more triumphs, more victories, more control and power. Given propitious conditions, a gifted man of this description may achieve high office. Most dictators whose biographies are known, especially some of the notorious figures of the Twentieth Century, seem to have been of this type.

Toughness, callousness and ruthlessness are, to a power-seeking person, the equivalent of strength. He suppresses all tender feelings and tends to be put off by demonstrations of affection. Softness, compassion, consideration are all treated as danger and weaknesses which might impede him in his fight for domination.



THEORETICAL DISCUSSION

The three-fold classification of the reactions to danger and the corresponding description of the three psychological types are due to Karen Horney[1] to whose work reference was made already in an earlier article. However, quite apart from any psychological findings, this theory would seem to appeal immediately to common sense based on ordinary experience of life. Moreover, both on the grounds of logic and of common observation, attack and escape, together with intermediary forms of reactions as, for instance, threat, cover all possible responses to danger. It is immediately obvious that escape can be either a movement *away* from danger into distance or solitary hiding, or it can be a movement *towards* the group, the herd, the parents or a strong individual.

Continuing Three Human Reactions

Children, as will be commonly observed, do not, on the whole, move *away* from danger or the object of their fear, indeed, it is accurate to say that, when frightened, they run *towards*, and cling to, their parents or other adults.

It would seem to be a fair summary of the facts to say that most, and possibly all, human beings and animals in their infancy, run *towards*, and cling to, their parents or the group. When older, some, both animals and men, learn, or mature, enough to escape *away* and to hide from danger. Others remain bound to the group or herd. Still fewer, and at a later stage, come to fight, to hit back and to attack. In view of this it is not unreasonable to suppose that seeking protection is somehow more fundamental than the other two modes of behaviour, and again, that escape is a more basic reaction to danger than counter-attack. This may account for the fact that we traditionally value friendliness and co-operation more than hostility and war.

In terms of our analogy with an automatically controlled system (see the diagram), which has been discussed in the previous article[4], these three basic reactions to a Danger Signal can be compared to three fundamental sub-routines within the Emergency Control. Which of them will be switched on when the Emergency Control takes over from the Main Control will depend partly on the characteristics of the system and partly on the properties of the danger signal, as well as on other information about the circumstances fed in simultaneously with it.

This picture agrees to a great extent with recent work, both experimental and theoretical, on animal behaviour. It was found, in a series of most interesting investigations, mostly by Lorenz and Tinbergen, that whether an animal attacks or escapes, is rigidly and automatically determined by well-defined properties of the situation and of what they call "releasing stimulus." Thus, to return to our analogy, a danger signal will not only cause the Emergency Control to take over from the Main Control, but, by virtue of being a specific "releasing stimulus" it will activate the corresponding "releasing mechanism" (another term introduced by these investigators of animal behaviour) to trigger off the appropriate sub-routine.

However, whether the number of fundamental sub-routines is two, three or more, these experiments with animal behaviour appear to lead to the conclusion that there is a finite number of discrete and distinguishable modes of action, some of which are mutually incompatible. In lower animals, for example insects, and also birds and fishes, the transition from one mode of action to another is in the form of a step function, that is, it is discontinuous and abrupt, whereas in mammals and more especially in primates and in man, these discrete mechanisms appear to combine into a smooth performance. The same conclusions are fully supported by the classical work of Charles Sherrington on the organisation of the central nervous system.

The performance of a well-adjusted man at a time when he is in full possession of his mental powers is smooth and every mode of action he adopts spontaneously is appropriate to the situation. In times of stress, and more frequently in those of us who are not so stable, the separate mechanisms fall out of tune with each other, they lose their proper calibration and synchronisation, are liable to hunt or jam and the performance becomes more crude and jerky. A person becomes more automatic, much less discriminating and subtle in his reactions and, it is almost true to say, takes a step down the evolutionary scale.

APPENDIX

The idea that there are the three basic character tendencies described here was first put forward by Karen Horney[1] in 1945. She has shown how these tendencies come into conflict with each other and produce a number of different character constellations which she has vividly and convincingly described. The theory has been further extended and elaborated in 1950.[5] Her approach differs considerably from Freud's, whose theories she discussed critically in *New Ways in Psychoanalysis*.[6]

The idea of *vicious circles* operating both *intrapsychically* and *interpersonally* is also due to her and has been put forward independently of cybernetics or information theory. Her analysis of human behaviour has been only recently combined with the theory of feed-back loops and automatic control.[2 3 4]

The discovery and the detailed investigation of discontinuities and of the step-functioning in animal behaviour is mainly due to Lorenz and Tinbergen, although these ideas have been anticipated before. Tinbergen's book[7] is the main treatise on the subject. He shows in it how these discrete components synchronise and dovetail to give an over-all continuous performance. An interesting and amusing introduction is provided by Lorenz's *King Solomon's Ring*.[8] Their work does not seem to have been at all inspired by psychology of human behaviour, and it is definitely independent of Karen Horney. Similarities, however, can be clearly observed on reading Tinbergen's brief article on *Fighting and Threat*,[9] which is another useful introduction to the subject.

Another aspect of Tinbergen's analysis[10] brings out the hierarchical organisation and superimposition of discrete mechanisms of instinctive behaviour. This seems to be in full agreement with Sherrington's classical work[11] on the integrative action of the nervous system in which the hierarchical structure and synchronisation at various levels of reflex mechanisms are clearly brought out. A clear and brief introduction to this subject can be found in Cobb's[12] chapter on *Segmental and Suprasegmental Aspects of the Cerebrospinal Nervous System*. An interesting experimental analysis of animal movement into discrete, automatic and apparently fully determined components is provided by Fraenkel and Gunn.[13]

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At the foot of the third column of the previous article,[4] the statement "the state of stress . . . may require functional autonomy" occurred; "acquire" should be substituted for "require."

Atomic Review

Bran Tub

FUSION as yet is largely a matter of the bran tub. Research teams pick a parcel or two at random, and begin to untie the strings, but it is not until the wrappings are removed that anyone can estimate the value of the contents. The Americans and Russians have paid their money and picked a number of approaches, any of which may prove successful. Britain came early, took a quick look at the shapes and sizes of the parcels before the others arrived, and has now chosen a likely one, at the same time running an appraising eye over the other packets. One such packet has been labelled cold fusion, and Mr. Alick Ashmore of the University of Liverpool has written for ENGINEERING an assessment of the catalysed fusion reaction, which, if practicable, would operate on this principle. Mr. Ashmore, with a number of colleagues, recently carried out experiments on catalysed fusion in the University Nuclear Physics Research Laboratory, and a summary of the results taken from a Physical Society paper follows Mr. Ashmore's own account. Other approaches to fusion and the problem of estimating temperature in thermonuclear plasmas are discussed in further notes by the Soviet physicist Academician I. V. Kurchatov and by Dr. A. E. Ruark, Head of the United States Atomic Energy Commission's Controlled Thermonuclear Branch.

CATALYSED FUSION REACTOR

By Alick Ashmore, B.SC.

In Atomic Review last 24 January an account was given of work done at the Universities of California and Liverpool on the fusion of hydrogen and deuterium (p—D reaction) catalysed by negative muons. The part played by the muon is to bind the two nuclei in a mesic molecular ion, so bringing them close enough together for fusion to occur. In the Liverpool experiment it was found that the average time for the formation of a molecule and its subsequent fusion was about four microseconds. This is nearly twice the natural mean life of the muon so that only about one third of the muons cause fusion. The rate at which fusions take place will, however, be many times greater in a molecule containing two deuterium atoms (D—D reaction), or a deuterium and a tritium atom (D—T reaction). In the time distribution of fusions observed at Liverpool there is a slow and fast component, but it is not possible to tell which is to be identified with the fusion process. According to whether the fusion is slow or fast, the molecule formation time may be as short as 0·05 microseconds or as long as several microseconds. The corresponding mean numbers of fusions per muon would be 40, or less than one. It is not by any means certain that the formation times will be the same for all the molecules, and so it could possibly be less than 0·05 microseconds for the D—D and D—T reactions. An experimental observation of the time distribution for these reactions would be of great interest.

The limit to the number of fusions per muon is not only set by time considerations. After fusion some of the muons are trapped in an orbit round the residual nucleus where they decay in the natural way. This is particularly likely in the case where a γ-ray is emitted (p—D and p—T reactions), since the recoil velocity of the residual nucleus is then comparable with that of the muon in its orbit. When a proton or neutron is emitted (D—D and D—T reactions) the recoil velocity is much higher and the muon is much more likely to be shaken off. At Liverpool it was found that 93 per cent of the muons were trapped in the p—D reaction. A theoretical estimate gives about 10 per cent for the D—D reaction and 1 per cent for the D—T reaction. Thus a long lived meson would cause an average of 100 fusions in a deuterium tritium mixture. This reaction is also the best as regards energy released (17·6 MeV).

A rough lower limit can be set for the number of fusions per muon required for a positive energy balance. Pions (π mesons) would be produced in nuclear collisions made by a high-energy proton beam in a thick target. To obtain a reasonable proportion of negative mesons the proton energy would have to be sufficiently high for the production of pion pairs, that is above 1·5 GeV. Even then the proportion would only be one third. The pions have an average life of 0·025 microseconds, decaying into a muon and a neutrino. They would have to be allowed to decay in flight, as otherwise negative pions would be captured by nuclei and thus not produce muons. The muons would be brought to rest in a mixture of deuterium and tritium gas, where after catalysing an average of n fusions they would decay into an electron and two neutrinos.

About a quarter of the proton energy will be given to the neutrinos and thus lost. The remaining energy, which is in the form of kinetic energy

of motion of particles in the target or gas mixture, could be recovered in the form of heat. A yield of the order of one pion per GeV of proton energy might be achieved. Of this 0·25 GeV would be lost as neutrinos, and 0·75 GeV recovered as heat. Since one third of the mesons are negative, the energy yield from fusion per GeV of proton energy would be $17 \cdot 6n/3 \simeq 6n$ MeV, also in the form of heat. With any conceivable generator only about one third of the heat could be converted into electrical energy and used to accelerate the protons. There would also be some loss of electrical energy in the accelerator although for a linear accelerator this is quite small. Thus at least 3 GeV of heat energy must be supplied for every GeV of proton energy. For a positive energy balance the energy yield from fusion per GeV of proton energy would have to exceed 2·25 GeV = 2,250 MeV. Thus n must exceed 2,250/6 = 375, which is well in excess of the limits set by molecule formation time and trapping. In practice the gap would be larger still since it has been assumed that all the pions leaving the target could be collected as muons in the gas mixture. To do this would be a very considerable technical achievement.

Cold Fusion

As background to the article above, we give below excerpts from a paper presented to the

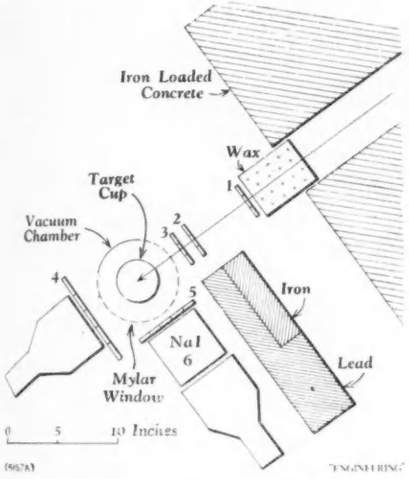


Fig. 1 Arrangement of experimental apparatus for investigating the gamma-ray emission from muon-catalysed fusion of hydrogen and deuterium.

1, 2, 3 Scintillator radiation counters arranged in triple coincidence counter telescope.
4, 5 Anti-coincidence counters.
6 Cylindrical sodium iodide [Na I (Tl)] counter.
Behind 4 and 6 are E.M.I. 6099 photomultipliers.

Physical Society, in which the experiments at Liverpool were reported. Fig. 1 shows the layout of the experimental apparatus, and Fig. 2 represents the assumed reaction scheme.

The cold fusion experiments of Dr. L. Alvarez have recently been extended at the University of Liverpool by Mr. A. Ashmore and others. Dr. Alvarez found that the stopping of negative muons in mixtures of hydrogen and deuterium is followed by a fusion reaction. Events were seen in a bubble chamber in which the muon was re-emitted with the energy released in the fusion process. In the experiments carried out at Liverpool the γ-rays from the fusion process were detected and a measurement made of their time distribution. The yield of γ-rays was found to be $0 \cdot 34 \pm 0 \cdot 06$ per muon stopping in liquid hydrogen enriched with 1·8 per cent of deuterium. A comparison with the results of Alvarez *et al.* gives an internal conversion coefficient of $0 \cdot 066 \pm 0 \cdot 014$. The analysis of the time distribution enables the following limits to be set on the two reaction rates involved:

$$0 \cdot 19 \times 10^6 \text{ sec}^{-1} < \lambda_{slow} < 0 \cdot 88 \times 10^6 \text{ sec}^{-1}$$

$$0 \cdot 55 \times 10^6 \text{ sec}^{-1} < \lambda_{fast} < 2 \times 10^7 \text{ sec}^{-1}.$$

A comparison with theory shows that it is not possible to assign them to particular processes in the chain of events following a muon stopping in the enriched mixture. The frequency of fusion reactions was measured by Alvarez for different deuterium concentrations. The number of events for each muon undergoing normal decay was $0 \cdot 6 \times 10^{-2}$ for 0·016 per cent, 2×10^{-2} for 0·3 per cent and $2 \cdot 5 \times 10^{-2}$ for 4·3 per cent concentration. The reaction is seen to be near saturation already in the region of 0·3 per cent concentration.

The reaction is assumed to proceed in the following steps. (1) The stopped negative muon is captured to form either a hydrogen or deuterium mesic atom. (2) The neutral hydrogen mesic atoms drift around and can exchange their muons with deuterium atoms. The exothermic nature of this exchange makes it highly probable. (3) The mesic atoms form mesic molecular ions with normal hydrogen and deuterium atoms. HH^+, HD^+ and DD^+ ions will be present. To obtain observable rates for the subsequent fusion of the HD^+ and DD^+ systems is it necessary to assume that the particles are confined in a mesic molecule. (4) The HD^+ and DD^+ mesic molecular ions fuse. HD^+ fuses to ^{3}He, and the excess energy, 5·5 MeV, leaves the excited ^{3}He system by the emission of a γ-ray or by internal

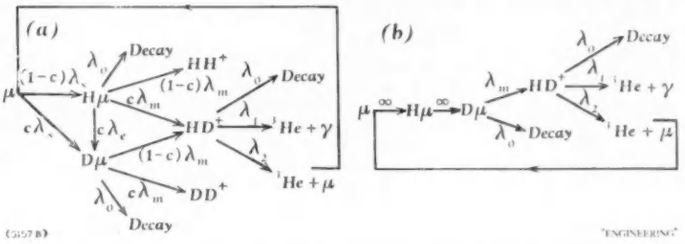


Fig. 2 Assumed reaction schemes for muon catalysed fusion of hydrogen and deuterium.

conversion to the muon bound in the system. The muon emitted in the internal conversion process can recycle the reaction. (5) At all times the muon can undergo normal decay to an electron and two neutrinos. The frequency of fusion suggests that the lifetime of the reaction is comparable with the lifetime of the muon.

The work at Liverpool was carried out using the negative meson beam of the University's 156 in synchrocyclotron. Mesons from the beam were stopped in a liquid hydrogen target. The paper, "The Gamma-Rays from Muon Catalysed Fusion of Hydrogen and Deuterium," by A. Ashmore, R. Nordhagen, K. Strauch and B. M. Townes, reporting the experiments performed in the Nuclear Physics Research Laboratory, University of Liverpool, has been published in the *Proceedings of the Physical Society*, vol. 71, p. 161, '58.

Kurchatov on Thermonuclear Reactors

A slightly abridged version of Academician I. V. Kurchatov's recent article in *Pravda* on thermonuclear reactions has been published (in English (in *Soviet Weekly*, 13 March). Reference to the *Pravda* article and to the production of deuterium by deep-freeze methods was made in Atomic Review last 7 March. Academician Kurchatov also discussed a number of thermonuclear problems already treated in ENGRG. (31 Jan. '58, p. 134, and 15 Nov. '57, p. 610), such as stability and the containment of ionised plasmas by pinch effect, and by the electromagnetic reaction of the containing tube if this is made of a conducting material. (Academician Kurchatov's paper on thermonuclear reactions delivered at Harwell in 1956 was published in ENGRG., vol. 181, p. 322, 1956.) Some other sections of the recent article are reprinted below.

A thermonuclear reactor should be able to heat deuterium to a temperature of 300 to 400 million° C or a mixture of deuterium and tritium to a temperature of 40 to 50 million° C. In gaseous deuterium at room temperature and normal pressure the molecules travel at speeds of more than 5,000 km/hour. If the gas is contained in a vessel made of material able to withstand tremendous temperatures and pressures, and heated to a temperature of 100,000° C, the pressure of the gas will reach about 1,500 atm, the deuterium atoms will disintegrate into positively charged deuterium nuclei and electrons, and consequently the gas will be fully ionised. Physicists call matter in this state, plasma. The deuterium nuclei will be moving about at a speed of slightly over 100,000 km/hour, but nevertheless the energy of motion of the deuterium nuclei will still be too small to overcome their mutual repulsion. At a temperature of 100,000° C, in 1 litre of deuterium plasma only two nuclear transformations will take place in a thousand years. If the temperature is increased to 100 million °C, the velocity of the deuterium nuclei becomes enormous, being about 1,000 km/sec. All the deuterium nuclei will react with one another in a fraction of a second. In 1 litre of plasma, energy will be released at a rate of 100 million kW, and the conditions will be those in which a self-sustaining thermonuclear reaction using deuterium is possible.

The pressure of the plasma will reach 1,500,000 atm, and it is quite clear that in such circumstances a thermonuclear reactor using deuterium at normal density is utterly out of the question. In a thermonuclear reactor the gas must have a very low density, with the number of particles per unit volume not more than a few hundred-thousandths of the number at normal pressure and temperature. Even then, plasma pressure will be of the order of tens of atmospheres owing to the tremendous temperature. The core of a thermonuclear reactor will be a hermetically sealed chamber from which the air must be pumped out before firing. The residual pressure will not exceed a ten-millionth of an atmosphere. The bigger a reactor, the higher is the proportion of the power given out to that used in the reactor itself. Therefore, there is a lower limit to size of a reactor which produces more power than it consumes. For a reactor using a mixture of deuterium and tritium the smallest practicable active zone will be about 1 m across. Reactors using pure deuterium will be bigger, and therefore suitable only for high-capacity stationary electric power plants.

There is a possibility of producing electric power directly from a thermonuclear reactor, dispensing with the intermediate low-efficiency thermal cycle. This was noted by G. I. Budker, who evolved one such machine in 1954 at the Atomic Energy Institute of the U.S.S.R. Academy of Sciences. This possibility is based on the fact that in the deuterium plasma more than two-thirds of all the power is emitted as the kinetic energy of charged particles. The charged particles are held by the magnetic field and it is not difficult to see that their kinetic energy can be converted directly into electrical energy. A pulsating electric current could be obtained, for example, in the following way. Let us assume that the plasma is held by the outer magnetic field beyond the walls of the reactor. Magnetic lines of forces will cross the field winding, generating electric current in it. At a certain point, the power of this current will be greater than the energy expended on compressing the plasma.

A. E. Ruark on Temperature of Plasmas

In a background note on United States controlled fusion research, supplied by Controlled Thermonuclear Branch, Division of Research, U.S.A.E.C., Dr. Arthur E. Ruark, Chief of the Branch, states that it is not quite correct to use the word temperature in describing the condition of man-made thermonuclear plasma. Originally it was used as a measure of the energy of the molecules, in cases where a body is quietly confined in a vessel, so that the various parts are all similar in their properties. This would be the case, very nearly, for a small

Continuing Atomic Review

body of gas near the centre of the sun. But in a pinched discharge there are necessarily currents, and the discharge gives out X-rays in great quantity. Under such conditions one can calculate a number of different values for what we may call an effective or nominal temperature. For example, from the neutron output we get a value which might be called " the temperature, judged by emitted neutrons." It is simply the value which the temperature would have to be, in a quiet plasma, in order to give the number of neutrons observed. Similarly, there can be a temperature calculated from the X-ray output, and so on. The various temperatures will not agree. In unskilled hands they can lead to confusion, but in the hands of experts, they can be used with confidence. Figs. 3 and 4 show American thermonuclear apparatus. A report on United States thermonuclear work appeared in ENGRG. 7 Feb., '58, p. 185.

Notes and News

Conference on High Energy Nuclear Physics

More than 200 scientists from 26 nations have been invited to participate in the 1958 Annual International Conference on High Energy Physics organised by the European Organisation for Nuclear Research (CERN) in Geneva, from 30 June to 5 July. This meeting continues a series of seven annual conferences on high energy nuclear physics previously held at Rochester, N.Y. CERN last played host to physicists from all parts of the world at the symposium on high energy accelerators and pion physics held in Geneva in the summer of 1956. Among the 226 scientists invited so far, over 100 have already accepted, among them physicists of world renown like Professor W. Heisenberg of Germany, who recently announced the discovery of a basic equation tying together all elementary particles (see Atomic Review, 7 and 14 March). During ten plenary sessions at the Auditorium of the Physics Institute of the University of Geneva, the physicists will exchange information on the fundamental properties of atomic nucleus. Papers will be presented on nucleon structure; the nucleon and its interactions with pions, photons, nucleons and antinucleons; fundamental theoretical ideas; strange particle production and interaction; invariance principles and selection rules, and weak interactions. The conference proceedings, including original papers presented, will be published by CERN.

Cyclotron for Colorado

A small cyclotron to provide research and training facilities is to be built for the newly established nuclear physics laboratory of the University of Colorado, Boulder, Colorado. The proposal is to construct a cyclotron having a 50 in diameter pole capable of accelerating protons to 30 MeV, deuterons and helium ions to 40 MeV and other heavy ions to comparable energies. Dr. David Lind, project director, who has designed the cyclotron has incorporated a number of new developments in accelerator design into the plans. It is hoped to start construction of the building to house the machine in May, 1958, and to install the heavy components of the accelerator in late 1958. Buildings should be completed early in 1959 and the machine completed and in operation early in 1960. Total cost will be about 1·3 million dol, and a proportion of this sum will be contributed by the Atomic Energy Commission of the United States.

All the planning, design and construction is the responsibility of the University of Colorado and all negotiations and contracts will be directly with the university. A preliminary set of drawings and specifications for the magnet frame and coils, together with a copy of the University's summary of the origin of and plans for the project are available for inspection at Export Services Branch, Lacon House, Theobald's Road, London, W.C.1 (quote E.S.B./4256/58).

Battelle's Research Reactor

Battelle's new research reactor serves as a high intensity source of neutrons and gamma rays for evaluating beneficial and detrimental effects of radiation on reactor materials, electrical components, and chemicals and chemical processes. It is also employed in exponential experiments involving fuel-element development. The critical assembly laboratory is specifically designed for execution of experiments at zero power on mocked-up reactor cores. Such experiments produce values for reactor design parameters that are needed to complete the core specifications. Reactor design work is conducted by a group of physicists who evaluate data from critical experiments and analyse existing and proposed reactors for operational feasibility. The division's heat-transfer research involves studies of void formation and variation of density of moderators under boiling heat flux conditions. Other work includes the improvement of techniques of the cyclic heat method of measuring average heat-transfer coefficients of reactor fuel systems.

Fig. 3 (right) Controlled thermonuclear reactions have been studied at the Los Alamos Scientific Laboratory, in America, using various forms of apparatus, including a toroidal gas discharge tube known as the Perhapsatron. Several versions of this equipment have been made.

Fig. 4 (below) In the Perhapsatron, illustrated here, temperatures of 3 million °C have been achieved for periods of about one millionth of a second. Glass or quartz may be used for the containing torus.

HAZEL Critical

A zero-energy homogeneous reactor assembly has recently been brought into operation at the Atomic Energy Research Establishment, Harwell. Enriched uranium in the form of uranyl fluoride serves as fuel and is dissolved in the heavy-water moderator. HAZEL—homogeneous (aqueous) assembly zero energy, presumably with the final letter taken from uranyl—is understood to be the second homogeneous reactor to come into operation at Harwell; the first was ZETR—zero-energy thermal reactor—which employed fuel of high enrichment with ordinary water as moderator. Though it is stated that the new reactor uses enriched fuel, enrichment is normally unnecessary when the moderator is heavy water. The fuel and moderator are circulated through the reactor core by pumps, so that in a fully developed homogeneous system continuous processing of the fuel would be possible. This characteristic is the main advantage of the homogeneous system.

The reactor core is contained in a stainless-steel cylinder, 7 ft high and 2 ft in diameter, surrounded by a graphite reflector. The fuel solution is pumped into the core from two storage vessels. The system is controlled by adjusting the level of the fuel solution in the reactor vessel, and by moving a vertical neutron-absorbing cadmium plate into the gap between the steel cylinder and the graphite reflector. Two cadmium plates, similar to the control device, are used as shut-off rods; two additional shut-off rods can be dropped vertically into the fuel solution in the reactor vessel. The reactor will be operated at a power of less than a watt, and cooling is not necessary.

The homogeneous reactor like certain other systems has recently been viewed with less favour in Britain than hitherto, owing to the formidable metallurgical and engineering problems involved. HAZEL has been built simply to obtain basic nuclear information, for which purpose a homogeneous reactor may well be specially suitable. On the other hand, feasibility studies for a homogeneous power reactor are likely to be continued by A.E.R.E. so that the fundamental technical data may be available should the system later prove practicable.

Remote Location and Long Operation

A power plant has been proposed whereby 7 500 kW of electrical power are produced by two identical nuclear reactors operating in parallel to supply a common boiler and, in turn, to drive a low-pressure steam turbine-generator set. The system is especially designed for power generation in an isolated location where fuel transportation difficulties make other power sources impractical. A new method of shim control is suggested, which reduces the otherwise high initial excess reactivity required for long periods of operation. The method involves the addition of a predetermined amount of nuclear poison to the fuel which is burned out at a rate comparable to that of the fissile material. This tends to maintain the multiplication factor of the reactor at a nearly constant value. (T. M. Hallman and others: Oak Ridge School of Reactor Technology, Tennessee.)

Marketing

WHY THE PRICE CUTS?

Several announcements of price reductions made recently by engineering companies have been received in the offices of ENGINEERING. The Federation of British Industries have also published the results of their first inquiry into industrial trends, which reveals that manufacturing industry was experiencing a general decline in profit margins, a fall in the rate of incoming orders but higher output. The most important finding, from the engineering industry's point of view, was that " industry is continuing to cut back markedly on capital spending plans." In a somewhat different context, Marks and Spencer announced another price cut, their fifth since they started their " new lower prices " campaign two months ago. The prices of basic industrial materials have fallen on average by some 10 per cent since the beginning of 1957, partly due to the slump in commodities triggered off by the United States recession, partly to the marked fall in freight rates which has helped to reduce the cost of imported materials, particularly bulky ones such as iron ore. The retail price index has been stable since September and the wage index has risen by only one point in the past ten months.

This brief review suggests that the price reductions are due to a number of factors, in which the fall in the rate of incoming orders predominates. *The Financial Times* commented recently that " there was no doubt that the tighter market conditions now being experienced by most manufacturers are tending to promote efficiency." It was primarily a deliberate and methodical attempt to increase efficiency which resulted in the Marks and Spencer price cuts: the improvement in the volume of sales which has taken place since then has encouraged others to follow suit.

The price reductions announced recently were not always explained. Where they were, it was increased production volume that was generally the reason given for the cuts. Announcing average reductions of 9 per cent in the prices of their range of silicon rectifiers, Ferranti commented that they were " a direct result of improved manufacturing facilities and mass production techniques." Crompton Parkinson's cuts in the prices of their series 5 range of a.c. motors (to BS 2960 : 1958) was attributed to " the ready acceptance by industry of Class E insulated 65° C temperature rise machines and consequent increased quantity production." Walker Croswell, manufacturers of mixing valves, announced the second price reduction in two months for their " Unatap " spray mixing tap due to " great demand at home and abroad." The Rootes Group went out of their way to emphasise that the prices of their Commer and Karrier trucks were being reduced " in spite of material prices rising generally " and because increased sales at home and overseas, " together with the streamlining of production," had resulted in increased efficiency and reductions in production costs. Dunlop Rubber have made the bare announcement that the retail prices of all popular sizes of their tyres will be reduced by 5 per cent from 1 March.

There is therefore a strong influence from increased output by more efficient methods: industry is now reaping its rewards for the heavy investment of the mid-1950's. Lower material prices must play their part, though—as Rootes' experience suggests—not so markedly in industries using mainly steel. The Government's drive to eliminate restrictive practices could also be an important factor, especially in the case of highly efficient firms who had followed an agreed price policy. Elsewhere there is room for a critical examination of production and distribution costs, as Marks and Spencer did so successfully. The realisation that this country's future depends on industry's ability to give good value for money, particularly overseas, should be enough encouragement. Human nature being as it is, however, the fear of losing out on price is likely to be the main spur to further cuts.

Heartening Confidence

The German economics minister, Dr. Erhard, told the 3,200 exhibitors at the consumer goods Frankfurt Fair that he saw no reason to be pessimistic concerning the future level of trade " provided industry did not try to solve its problems by curtailing output or raising prices." He expressed his confidence in maintaining trade activity at its present " fair to middle level."

Dr. Erhard's words will find an audience far beyond Frankfurt. As the architect of Germany's post-war recovery he has acquired a reputation for solving all problems by expansion of output and of investment. To achieve this he battles relentlessly at price maintenance agreements, and all restrictive practices so universally used in Germany between the wars to avoid fluctuations in trade. It is a fallacy, he said, that economic slumps must unavoidably occur from time to time. Dr. Erhard is a great believer in private enterprise of the dynamic kind, and has proved over the past four years that industry—given freedom and denied protection—will find a way to sustain rising output.

Two days of Wizardry

The two-day course held at Caxton Hall, London, " The Art of Selling," has created very lively comment in engineering circles. Among those who attended them was a surprisingly large contigent of engineering salesmen. One old-established company whose name is a household word in the manufacturing industry sent the manager of their large sales force who took with him two of his senior executives, " just to see for themselves if there was anything in this type of sales education for the technical representative." A number of other engineering firms went for similar reasons.

The reaction of these three men—all highly qualified engineers, with extensive design and production knowledge as well as sales experience—was that the first day of the course was somewhat of a waste of time. Sales psychology, sales arguments and hints on how to conduct an interview appeared ludicrously out of tune with the very different approach of the technical representative (the purists among whom dislike being called " sales " engineers and, still worse, " salesmen") who establishes a relationship where the product or the problem, not the men involved, forms the foundations. They warmed up to the second day's programme, and saw the possibilities of following the methods outlined in the last session.

This was a useful experiment for the firms concerned. Increasingly, the emphasis in engineering will shift to sales; more and more people will need to know how to establish a relationship, overcome resistances, clinch a deal. There is method in sales and " technical representatives " need to learn very much the same lessons as do " salesmen."

A " B " for a " P "

Shameless copying of high quality British products by foreign firms has recently received some publicity, even in Japan. There has now been further developments in the Pollard Bearings case (first discussed in these columns on 17 January) where close replicas of the ball bearing container were being marketed by Japanese firms with a B substituted for the P. After receiving a public apology from the Japanese Government, who attributed the offence to small firms " unfamiliar with international customs," they now find similar packages being distributed in the Canadian market. This time, however, Pollard's sales agent says that the sales circular accompanying the Japanese sales drive describes the bearings as " the very finest precision bearings manufactured by Mitsui heavy industry in Japan."

This seems somewhat strange and not a little silly. Heavy industry does not make precision ball bearings, and the Pollard name is unlikely to prove an open sesame in the dollar market, even less when amended to read Bollard. The reason would appear to be the desire to shelter behind the British reputation for quality, and thereby to lessen the adherence of the low-quality tab the Japanese acquired between the wars. Only if the bearings were of low quality would this particular practice seriously harm the British firms. On the contrary, they could benefit from the Japanese expenditure on publicity and other sales promotion measures.

Drive on the Genuine

Like Pollard Bearings, Girling Limited are concerned with the source of pirate replacement parts in place of their own. They have just launched a pilot sales and publicity scheme " to emphasise the importance to the motorist of using genuine parts, especially factory re-lined brake shoes." A leaflet is being distributed to all garages in the area, pointing out the need to educate the motorist to change his brake shoes regularly before they lose efficiency as he will " automatically change his tyres at reasonable signs of wear." The case for genuine spares rests on savings in fitters' time, due to correct riveting or binding.

This campaign implies—without saying so—that the pirate parts, as they are generally known in the trade, are inferior and different from the genuine. Generally also they are cheaper, since the manufacturers need not make any loss of profit on initial equipment sales to the car firms by fixing a high price for replacement parts. To firms like Girling they are an essential source of profitability. This problem is now becoming widespread in the industry. Girling's experimental effort to arrest the motorist's tendency to buy parts at the lowest possible price ought, for good reason, to succeed.

Russian Contract

The British consortium of engineering companies, Rustyfa Limited, who were awarded the first contracts last September for the plant and equipment required to equip a large new rubber factory in the Ukraine have been awarded further contracts valued at more than £5 million. The total value of the orders placed to date is £12½ million, with more to come. The tyre factory will have a capacity of 2 million tyres a year and will incorporate the most advanced techniques and machinery. The latest group of orders cover pneumatic handling and weighing equipment, impregnation plant, rubber processing plant and associated electric motors, tyre testing equipment, electrical distribution, substation equipment and control panels.

The idea of a consortium of companies for handling large projects is not a new one: it has been further developed latterly in the nuclear engineering field. Nonetheless, Rustyfa is original in its conception. It arose out of a delegation which visited Moscow in July of last year. The member companies—David Bridge, Crompton Parkinson, Lancashire Dynamo, Mather and Platt, Simon Handling Engineers and Geo. W. King—are represented on the Rustyfa board and the work is co-ordinated by the Rustyfa secretary. It would seem a very good way in which to secure orders for complete factories each involving many suppliers, and to deal with monopoly or State buyers. It is an idea which British industry might well consider more seriously as a means of furthering British exports.

Automobile Engineering

TEST-BED TESTS FOR CARS

Two unusual pieces of test equipment have recently been put into service. The first, at Jaguar Cars Limited, is for testing gearboxes and the second, at Associated Ethyl Company, Limited, Bletchley, for checking the performance of complete vehicles. Both were supplied by Heenan and Froude, Limited, Worcester.

The plant at Jaguars is shown in Fig. 1 and schematically in Fig. 2. It has been designed to test gearboxes at varying speeds at all ratios and to simulate road conditions as far as possible.

The gearbox to be tested, complete with its clutch, is mounted in a sound-proofed chamber and has shafts passing through both end walls. Each shaft is driven through a Dynamatic eddy-current coupling by a constant-speed motor. One represents the normal drive to the box and the second (on the gearbox output shaft) is used to simulate overrun conditions. All controls are mounted within the chamber in reach of a single operator, and consist of Heenan-Dynamatic equipment. Engine speed and load are controlled by the couplings, which can be used as either driving units or brakes. A clutch pedal allows gearchanging to be carried out as on the road.

The unit installed at the Associated Ethyl laboratory is more elaborate in that it is designed to assess the matching of fuels and engines by studying the performance of a complete vehicle. Briefly, the car under test is anchored to the bed by its front wheels, with its rear wheels standing on rollers. The latter can be braked or motored as desired, all controls being installed in a separate room looking on to the test space. The general arrangement is shown in Fig. 3. At the front of the car is a duct (adjustable in length) through which air can be blown to simulate movement, equivalent to a maximum road speed of 80 m.p.h. Smaller fans provide cooling for the tyres. The driver in the car is in telephonic communication with the control room.

A schematic layout of the plant is shown in Fig. 5. The two rollers, each 4 ft in diameter and 2 ft wide, are so spaced that almost any vehicle can be accommodated on them. They are joined by a standard Eaton heavy-vehicle axle with ratios of 6·14 and 4·5 to 1. The torque from the axle casing is taken by a lever system to an Avery weigher in the control room. From the differential (which is locked) the drive is taken by a cardan shaft to a group of discs that can be coupled together to give the equivalent of the vehicle inertia in starting and stopping. A Dynamatic dynamometer capable of absorbing 300 h.p. at speeds between 2,400 and 6,000 r.p.m. supplies the load. The increase in speed due to the axle ratio allows both smaller weights and a smaller dynamometer to be used.

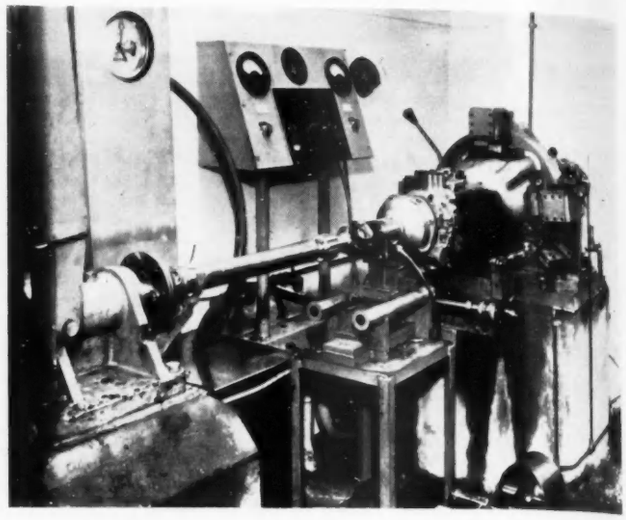
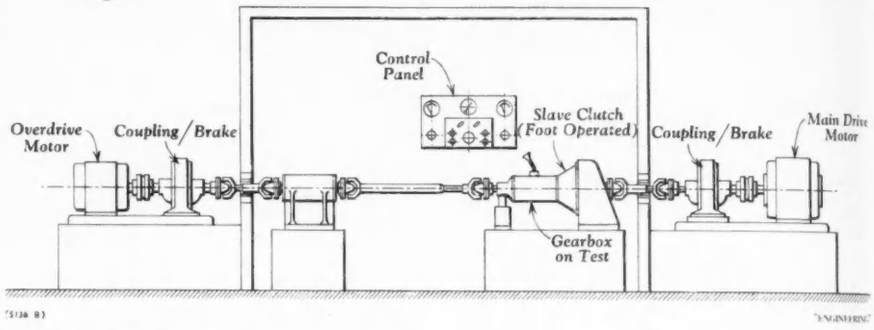


Fig. 1 (right) Gearbox tests are made in a sound-proof room. The arrangement is shown diagrammatically in Fig. 2 below.

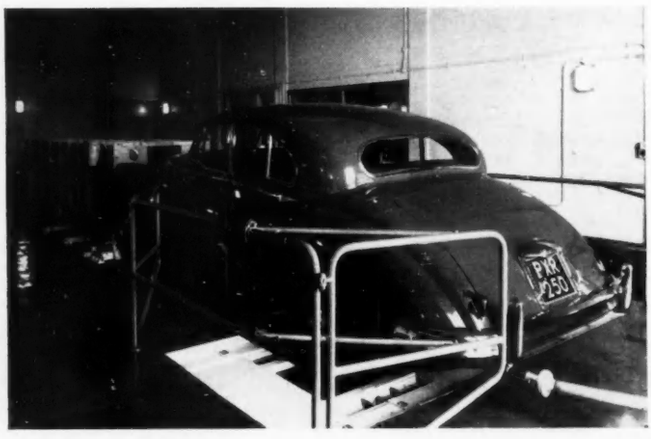
Fig. 2



For motoring the engine, that is, for simulating overrun or running down hill, a 100 h.p. motor is provided. This drives through a Dynamatic slip coupling and a belt and pulley system on to one end of another standard axle of a smaller type. The output from the differential of this is taken back to the output side of the dynamometer through another cardan shaft. Friction clutches on the axle allow the two fans to be engaged at will. Thus it is also possible to use either or both fans as part of the loading of the engine, again reducing the size of dynamometer and inertia weight. Both clutches can be operated from the control room.

During a typical test the driver in the car starts up and accelerates away as if he were on the road, changing gear at the appropriate speeds. The operator in the control room applies load to simulate movement along the level or up or down hill as desired. Provision is also made for the driver to control the load by a small portable electronic unit that can be stood beside him in the car. It is perfectly possible to arrange a "route" for the car to follow, adjusting the loading according to a pre-arranged plan. Also, the electronic equipment can be set so that the dynamometer loading follows, a constant speed, constant torque or a cube law.

One of the main advantages of the installation over a road test is that the conditions can be exactly reproduced at will, so that a direct comparison of different fuels can be made. Changing over from driving to motoring is a



Figs. 3 and 4 At Bletchley, direct comparisons of vehicle performance using different fuels can be made over "routes" set up on the control desk.

GERMANY DOMINATES SWISS AUTOMOBILE MARKETS

By Gordon Wilkins

The Swiss vehicle market, if not saturated, seems to be reaching a certain stabilisation of demand. Car sales last year, at 57,788, showed a rise of only 3 per cent over the previous year and commercial vehicle sales at 4,968 showed a drop of about the same proportion. The British industry continues to lose ground steadily in this market which, although intrinsically not very large, is an important indicator of consumer preferences. Having dropped by 6½ per cent compared with the previous year, British car sales are now fourth, representing only 10 per cent of the total. Volkswagen, with 12,317 sales in 1957, sold 2·2 times as many cars as the entire British industry. In the commercial vehicle field, Germany sells nearly twice as many vehicles as all other nations combined, and sold nine vehicles to Britain's one. Much of this is due to past faults of design, construction and service, for which we are now paying heavily. Ford and Vauxhall accounted for 60 per cent of British car sales and the remaining manufacturers often achieved only a few dozen sales. Standard sold 34 cars in Switzerland—only one-fifth of the sales achieved by the Czechoslovakian Skoda.

Apart from the efforts of the specialist coach-builders, there was little new to be seen last month at the Geneva Motor Show among the private car exhibits. Sweden's Volvo Amazon saloon appeared for the first time, with the twin-carburettor 85 b.h.p. version of the 1,580 c.c four-cylinder engine and a four-speed all-synchromesh gearbox. The Vauxhall Victor appeared with much more exterior chromium as turned out by the General Motors Swiss assembly plant. The revived Rambler American, the American Motors Corporation's effort to compete with European imports on the American market, appeared in Europe for the first time but its austere finish will not find it many buyers at 13,500 Swiss francs, which is 25 per cent more than the price of a Ford Zephyr, 13 per cent more than a Vauxhall Cresta, and 17½ per cent more than Simca's handsome V8 Beaulieu.

French exhibitors were somewhat embarrassed by the appearance of a so-called atom car project which had even less foundation in reality than appeared from the first reports and was dressed in a body of atrocious appearance which diverted attention from the one or two interesting ideas it contained. Among these were doors split horizontally, the upper half sliding up into the roof and the lower half dropping down under the floor. There was also an easily-read speedometer with a transparent scale projecting against the glass of the windscreen.

The large and comprehensive commercial vehicle section showed that something of a revolution is taking place and design is undergoing the most far-reaching changes since the war. In Germany, severe restrictions on vehicle weight and train length are leading to great activity in the production of lighter vehicles and engines giving higher power to weight ratios. The appearance of the vast T.100 Berliet, claimed probably with justification to be the biggest truck in the world, illustrates the stimulus which has been given to new developments in the French industry by the Sahara oil exploration programme.

Henschel displayed a new diesel engine with Motosacoche compressor giving 150 b.h.p., and there was a new short-wheelbase O.M. 3 ton truck built by Berna with 65 b.h.p. diesel engine offered either as four-wheel drive cross country vehicle, or as a front-wheel drive road vehicle, a De Dion front axle being used in the latter case.

Magirus-Deutz showed a new coach with air suspension; and on a new Swiss Schindler coach, which has all-independent suspension by double wishbones, air cushions are offered as an alternative to coil springs. Penetration of modern techniques into the truck field was exemplified by a new Saurer for transporting iron bars, which has an under-floor engine with forced induction, an eight-speed gearbox with electro-pneumatic shift, servo steering and progressive leaf-spring suspension.

The Berliet T.100 was shown as a six-wheeler platform truck for all-up weights of 80 tons. It is also projected as a heavy tipper for big earth-moving projects with all-up weights of 100 tons, or as a six-wheel tractor for semi-trailer units carrying large indivisible loads up to 80 tons (gross train weight 120 tons). For Sahara service, it is equipped with Michelin X tyres of 27-33 in, giving an overall diameter of over 7 ft and a specific ground loading comparable with much smaller vehicles. It is driven by a V-12 diesel engine of 30 litres with two turbo-blowers, giving 595 b.h.p., and is suitable for use with a variety of fuels. Two air-compressors and a pump for the servo steering lighten the work of driving it, and the transmission is through an eight-speed gearbox. All six wheels are driven, through triple reduction gearing, the last stage being by planetary gears in the wheels.

Continuing Test-Bed Tests

matter of seconds, so figures for friction losses can be obtained without any significant change in the engine conditions occuring due to delay. With the cooling fans driven from the rollers the degree of engine cooling approximates very closely to that which would occur if the car were running on the road. Means have also been provided for some of the warmed air to be recirculated to the ducting giving the effect of running at a higher ambient temperature.

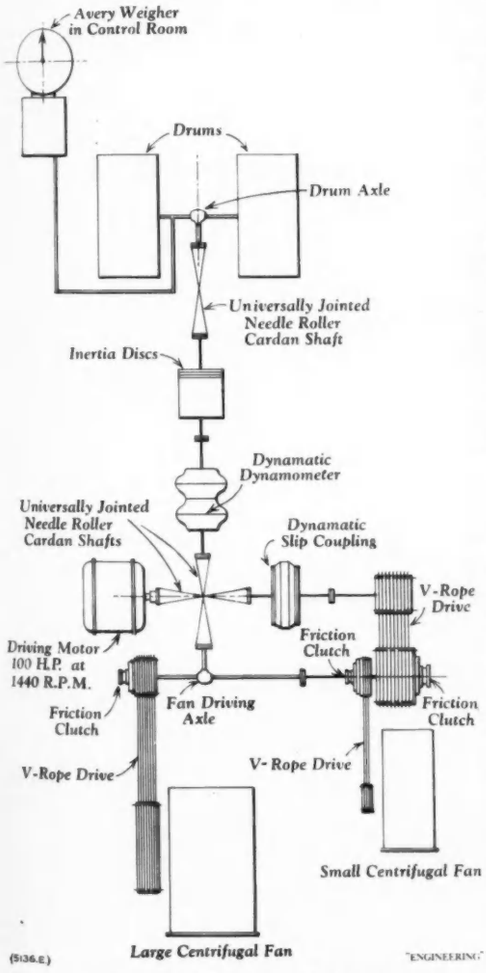


Fig. 5 Diagrammatic arrangement for chassis test plant.

NEW ECONOMY CAR

The new Gill Getabout car is based on the Astra, and has undergone extensive development during the past two or three years. It is powered by an Anzani 322 c.c twin two-stroke fan-cooled engine mounted at the rear, developing 15 b.h.p. at 4,800 rev/min. It has chain drive and independent suspension on all four wheels. The engine, gearbox and differential form a complete self-contained unit which is easily accessible and can be removed from the car in half an hour.

The body is of light rustless aluminium panels mounted on a chassis built of steel channel with jacking points. Total weight is 728 lb and the body bolts together in sections for easy replacement. There are Girling hydraulic brakes on all four wheels and a piston type handbrake for parking.

The overall length is 9 ft 6 in (wheelbase 6 ft 2 in) and the car is only 4 ft 5 in wide. The turning circle is 22 ft which is about the same as for a London taxi which seems able to turn anywhere, any time, so the Getabout should prove invaluable for parking in limited spaces. The steering uses a Burman worm and nut mechanism.

Top speed is said to be 50 m.p.h. and fuel consumption is 60 m.p.g. There is a two-spoke steering wheel, and a 4 gall fuel tank is situated under the front bonnet.

Front seat visibility is good and there is exceptionally good rear vision from the wrap-round Perspex window. There are also Perspex drop-down windows in the doors. The bench type seat at the front takes 2/3 people and there is good space for luggage behind.

The Getabout is made at Hampton, Middlesex, and at the moment production is up to 20 a week; to conserve shipping space, bodies can be assembled at their destination by simple bolting and riveting in any reasonably-sized garage or workshop. Delivery is one month and the car comes in two versions, the standard at a basic price of £322 5*s*. and the de luxe version at £348.

2 CV CITROEN WITH 4-WHEEL DRIVE

For personnel transport in the Sahara where France is making an enormous effort to exploit the oil and minerals that lie under the desert, Citroen has produced a four-wheel drive version of the famous 2 CV. This was achieved quite simply by installing a second engine and gearbox in the luggage trunk to drive the rear wheels.

Even with this extra weight, the car only weighs 1,408 lb; the unit loading on the tyres is thus quite low and it is said that normal tyre pressures can be used even in deep sand. The car is said to be capable of climbing a gradient of 1 in 2½ in sand, a remarkable performance for such a light, cheap utility car. It is expected to find a ready sale among building contractors, farmers and overseas users. The rear end of the car is modified to allow cool air to reach the engine, but otherwise the car is almost indistinguishable from the single-engine front-wheel-drive standard model. The two 425 c.c flat twin engines each developing 14-15 b.h.p. give a total of 28-30 b.h.p., equivalent to 44·6-47·8 b.h.p./ton unladen. Fuel consumption is said to be 25-31 m.p.g. according to terrain.

Research and Development

BRISTOL'S HIGH-ALTITUDE TEST PLANT FOR RAM-JET ENGINES

Mach 3·5 at 100,000 feet

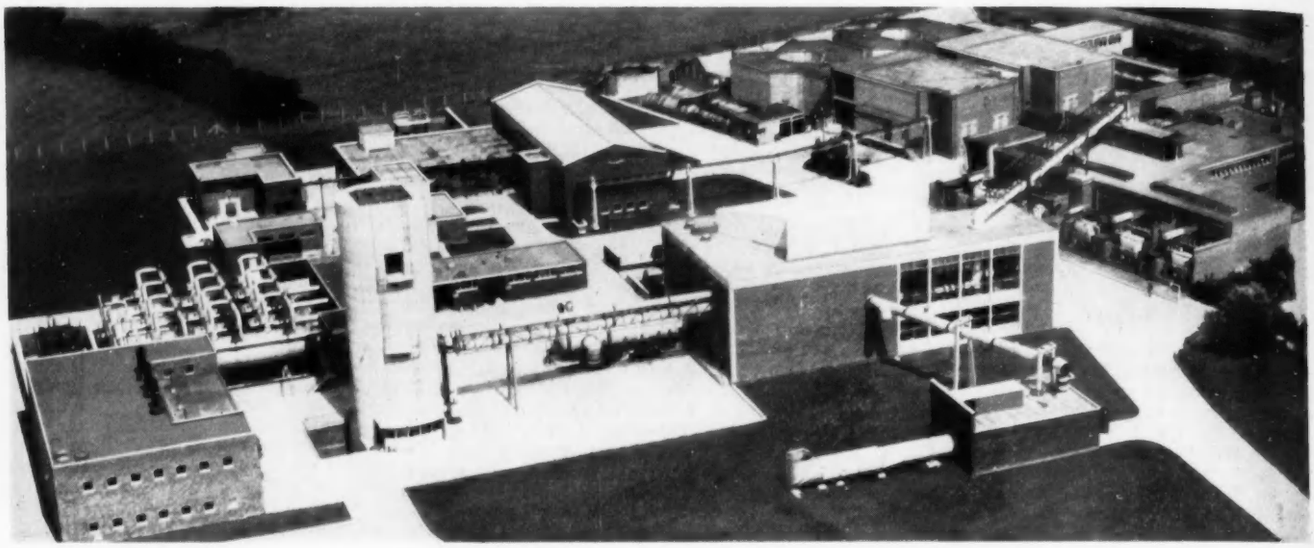


Fig. 1 Aerial view of Bristol's complex of ram-jet test facilities, with the new high-altitude plant in the foreground.

IN BRITAIN, the ram-jet engine is about to enter the first phase of its useful public life. The sustainer motors of the first British surface-to-air weapon, Bloodhound, to be delivered to the Royal Air Force are Thor ram-jets made by Bristol Aero-Engines Limited, Filton. They were chosen for their light weight, comparative simplicity and the fact that they are much more economical in consumption than rocket engines. The ram-jet is now only at the beginning of its potentialities, and bigger ram-jets suitable for longer-range atmospheric tactical weapons are already being worked out. Looking farther into the future, a wide field of application can be foreseen for ram-jet engines extending ultimately to the long-range British supersonic airliners that the President of the Royal Aeronautical Society, Sir George Edwards, hopes to see coming into world use in the 1970's.

The ram-jet engine comes into its own at speeds above Mach 2 and at altitudes rather higher than those preferred by the turbo-jet engine. For the development of supersonic engines elaborate test facilities are essential—as indicated in a series of articles on the facilities of the National Gas Turbine Establishment, Pyestock (ENGRG., 14, 21, 28 June, '57). We give below a description of the high altitude test plant recently put into operation by Bristol Aero-Engines Limited for the further development of ram-jet engines, which plant was officially inaugurated on Wednesday, 2 April by Air Marshal Sir Geoffrey Tuttle.

Fig. 2 An altitude test is in progress: the ejectors are blowing-off steam through the exhaust silencing tower and thus creating a depression in the test cell. The high-altitude building is seen to the left.

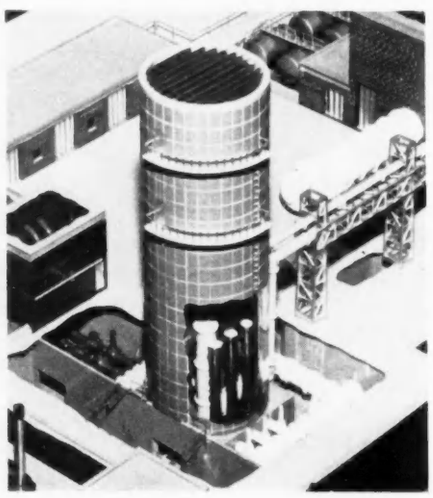


Fig. 3 A model of the exhaust tower cut away to show the steam ejectors and exhaust ducts.

The new high-altitude plant, shown from the air in Fig. 1, is the latest addition to a complex of development facilities at Gipsy Patch, Bristol, that has been built up over the past eight years and in which Bristol have already gained wide basic experience of the ways of ram-jets. The earlier plant includes so-called " sea-level " test-beds (in fact, capable of simulating altitudes up to 30,000 ft) for running complete engines up to speeds of Mach 2·5; " No. 1 " air station, which serves both the sea-level rigs and the new high-altitude plant; supersonic tunnels for developing air intakes; an auxiliary test-house for testing fuel turbo-pumps and control systems, and hydraulic turbo-pumps for the power-supply of missile control systems; and a pilot combustion rig for the initial development of combustion systems, the latter being fed by " No. 2 " air station.

The high-altitude test plant provides for testing the complete range of operation of a ram-jet engine over simulated altitudes from sea-level to 100,000 ft—at moderate supersonic speeds at low altitudes, rising to Mach 3·5, which can be reproduced from 63,000 to 100,000 ft. At sea-level conditions, it is possible to " accelerate " the engine from light-up to Mach 1·6 with the aid of a slotted nozzle developed by Bristol for testing over the transonic region. Three to four tests can be carried out in one day. The " free jet " method of testing is used, in which a jet of air at the flight velocity, total pressure and temperature, is directed by an appropriately-chosen convergent-divergent nozzle over the engine air intake. The test takes place in a cylindrical cell, the ambient pressure of which is maintained at the value appropriate to the flight altitude. Thus, the necessary services include a means of suction for achieving the low ambient pressures at high altitudes; a high-pressure air supply for simulating intake pressures at the lower altitudes where the air density is high; means for heating or cooling the air before it is directed over the air intake, to represent various flight conditions; and cooling-water supplies for the tail pipe and other items.

BLOW-DOWN TUNNEL

In altitude tests, the plant operates as a "blow-down" tunnel; a depression is formed in the test cell by means of six steam ejectors, with two alternative nozzle sizes to suit varying test conditions, supplied from four steam accumulators with a total steam storage capacity of 100,000 lb. Fig. 2 shows the ejectors blowing-off through the silencing exhaust tower during a test. The period of discharge at the maximum rate is approximately seven minutes, and this may be increased, at lower discharge rates, depending on the number and size of the steam ejectors in operation. In this short time it is possible to carry out some four or five complete combustion tests from light-up to rich or weak extinction, for the chosen flight condition.

High-pressure air for the plant, required only at altitudes below 50,000 ft, is supplied from "No. 1" air station by four Proteus compressors, giving a total delivery of 150 lb/sec of air at a pressure of six atm. Their output is ducted out of the air station, at roof level, across a road to enter the air-conditioning room on the upper floor of the high-altitude test plant. In the air-conditioning room are an electric storage heater, capable of raising the air temperature from 260° C (compressor delivery temperature) to 450° C; and two paralleled water-cooled air coolers which can reduce the air temperature down to 95° C.

The compressor delivery air can pass through either of these or it can be conveyed by ducts direct to a settling chamber at the entry to the test cell, which is located on the ground floor. At altitudes above 50,000, when compressed air is unnecessary, ambient air is drawn in from an intake situated upstream of the air heater.

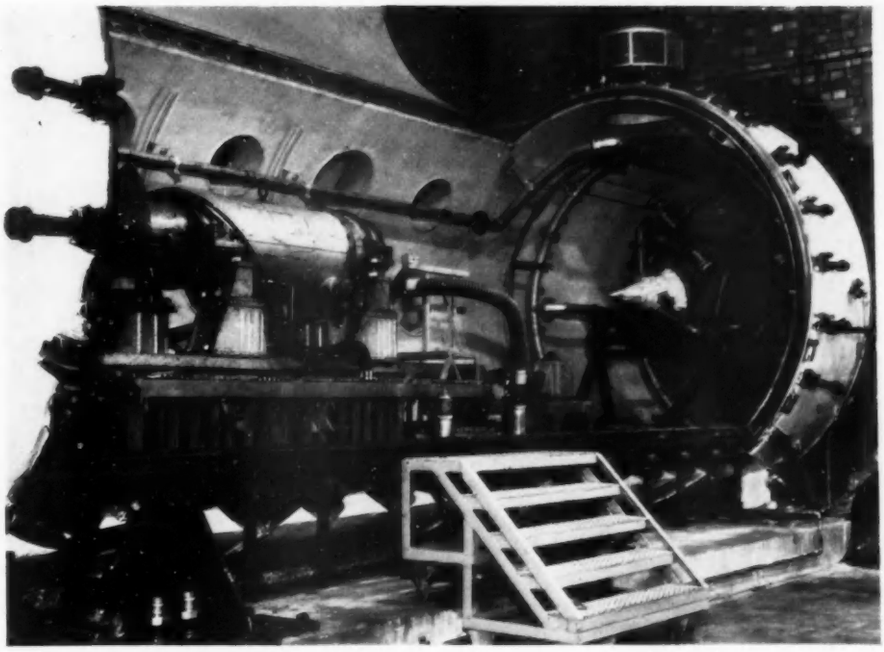


Fig. 4 Access to the interior of the steel test cell is through a large counterbalanced side-opening door, shown open and with an engine mounted ready for test. At the downstream end (right) the exhaust gases are cooled by water spray rings and a cone.

Fig. 5 The control room from which the entire test is regulated. On the side wall (left), are the controls for the steam supply and ejectors, and (right) air supply and conditioning system. Overlooking the test cell (right), are the fuel-system and cooling-water system controls.

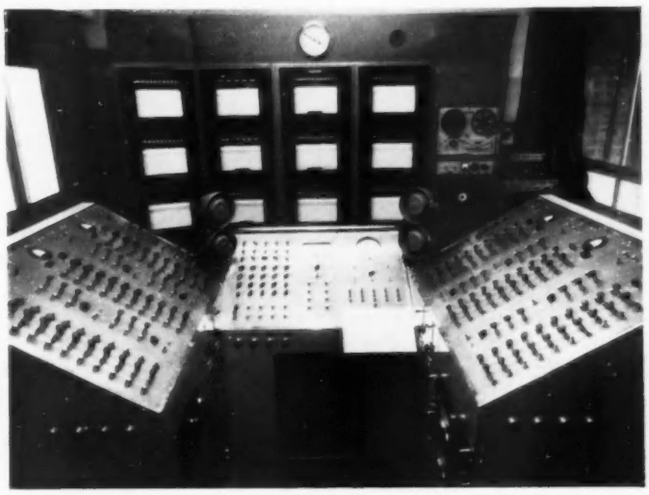


Fig. 6 The electronic room, situated in the sea-level test house, from which all test instrumentation for the whole facility is monitored. Transient vibrations are recorded on the tape recorder which is to be seen on the right back wall.

The ram-jet exhaust and the excess air from the blowing nozzle, which spills over the engine, pass out from the water-cooled downstream end of the test cell, through an exit in the side, and are taken underground to the base of the 100 ft high exhaust silencing tower, which is sunk some 20 ft below ground level. Here, the duct splits into three branches; the centre one provides for exhausting the test cell at atmospheric pressure, for low-altitude tests; and the two outer branches are each connected with the three steam ejectors. Fig. 3, which depicts a model of the plant, shows the tower cut away to reveal the disposition of the ejectors and ducts. Above the ejectors is a central expansion zone and an upper silencing section which is fitted with Muffelite glass-wool splitters supplied by the Cementation Company Limited, Doncaster.

TEST CELL

The test cell is partly housed within the main high-altitude building, but some 40 ft of the exhaust end protrudes beyond the building and is free to move axially to take up thermal expansion.

Overall, the cell is 75 ft long and 10 ft in diameter. The shell, of molybdenum steel, is of welded construction by Babcock and Wilcox Limited, 1 in thick and stiffened at 5 ft intervals. It has been proved for a depression equivalent to an absolute pressure of 1 lb per sq in and a pressure of 75 lb per sq. in.

A feature which greatly facilitates adjusting or changing the test-engine set-up is the large side-opening door, 20 ft long which, as shown in Fig. 4, gives ready access to the interior of the cells. The door, which weighs 10 tons, is counterbalanced and winch-operated. A test engine, mounted on its swinging stand, can be seen in the illustration, but the convergent-divergent blowing nozzle is out of view on the left. At the downstream end of the cell are the water-cooling spray cone in the centre of the ram-jet exhaust stream and spray rings at intervals around the walls of the test cell, which reduce the exhaust gas temperature from some 2,000° C as it emerges from the tailpipe to less than 100° C at the point where it leaves the cell.

To guard against accidents in operating the plant, in addition to various built-in safeguards, a rigorous schedule of pre-test and post-test checks has to be followed by the operators, including a fresh-air purge of the cell after every run. During a test, no personnel are allowed in the room housing the test cell; the whole plant is regulated and the test is observed from an adjacent control room, the test cell being provided with high temperature and pressure-resistant observation windows. The vast quantities of fuel and air pumped into the test cell constitute a sizeable explosion hazard,

XUM

Continuing Research and Development

and protective interlocks are provided between the fuel and air control valves and the high-energy ignition system to prevent misuse. In the event of some imminent mishap becoming apparent to one of the operators, emergency push-buttons are located at various strategic points for isolating fuel supplies and ignition and by-passing air supplies.

The cell itself is equipped with a Graviner explosion-venting system (see ENGRG., vol. 174, '54, p. 493) of the type in which detonator-actuated glass bursting discs are triggered off by pressure detectors responding to the absolute pressure within the cell; these are normally set to 5 lb per sq. in gauge. A Graviner explosion-suppression system is fitted in the underground exhaust duct from the cell; should a flame enter the duct, it would be detected by a photocell, which fires a cartridge releasing chlorobromomethane and flooding the duct with inert gas.

CONTROL AND MEASUREMENT

Fig. 5 shows the control room from which the entire test can be push-button controlled by four operators, under the supervision of a technical assistant. On the side wall, below the mimic diagram of the plant, are the control panels for the steam supply and ejector system, on the left, and the air supply and conditioning system on the right. By the control desk, looking out on to the cell, are the fuel system controls (right), the altitude trimming control (left centre) and the cooling-water system controls (extreme left).

Adjacent to the control room is a photographic recording room in which all the remote-indicating test instruments can be recorded on film. Instrumentation is provided in the control room for setting up the test conditions, including the engine fuel supply; all the test recordings are made in the photographic room and in an "electronic room" in the sea-level test house, wherein is concentrated the recording system for the whole facility. Here electrical signals transmitted by transducers mounted on the test engine are continuously received and recorded on Honeywell-Brown chart recorders. Later it is intended to add digitiser discs to the Honeywell-Brown recorders so that, in addition to the chart records, the results will be automatically transcribed to punched cards for analysis on the company's DEUCE computer.

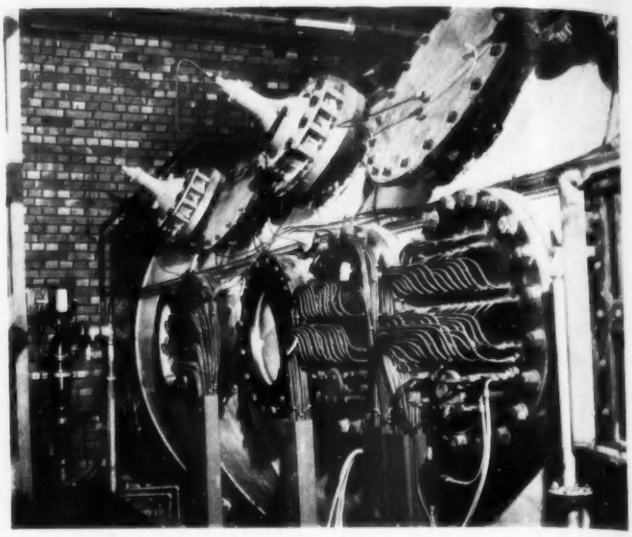


Fig. 7 The instrument leads from the test engine are brought out through manifold plates.

Also located in the electronic room is a magnetic tape-recording system, originally developed for the detection of "screech," which is used to record transient vibrations picked up by a transducer mounted on the engine. The tape recordings are subsequently passed through a frequency analyser to reveal the peak frequencies.

Depending on the nature of the test, up to about 100 measurements may be involved. Fig. 7 shows the manifold plates on the test cell through which the instrument leads are brought out to the recording room. The measurements will include fuel flow, air intake pressure and temperature, i.e., air mass flow, engine thrust, and a range of temperature and pressure measurements revealing the behaviour of the distribution and combustion system. Fuel flow is metered by transmitting Rotameters in the fuel supply system before it enters the test cell; temperatures are determined by thermocouples directly linked to the recorder. Bristol have developed their own linear temperature-compensated thrust and pressure transducers, the latter being adaptable for measuring either gauge or differential pressures, and comprising a strain-gauge metal diaphragm rigidly supported round its periphery, with its support ring integral with it, machined with high precision from a solid disc. The thrust transducer comprises a thrust-ring on which are mounted four strain gauges connected in bridge form; owing to the high temperature in the test cell (up to 450° C) it has to be enclosed in a water-cooled casing, the load being transmitted through double diaphragms.

(To be continued)

FLAME ARRESTERS FOR GAS OR VAPOUR EXPLOSIONS

*By K. N. Palmer**

Devices specially designed for mounting in ducting, industrial plant, or other systems in which combustible gas or vapour mixtures can be formed, are called flame arresters or flame traps, and they act as a safety measure to prevent the spread of flame throughout the system if the mixture should become ignited. Usually the arresters are in the form of a solid pack having small apertures which are expected to stop flames but to allow the passage of the gas. As the present design of flame arresters appears to be largely on an *ad hoc* basis, a systematic investigation is being made at the Fire Research Station to provide the detailed information necessary for scientific design. As a first step, experiments have been made with wire-gauze arresters, which are of simple construction and in common use and are available in a wide range of sizes of aperture.

In the experiments so far undertaken the cleaned dry gauze has been fixed across a vertical Perspex tube, open at the lower end, the internal diameter of which is 2½ in and the overall length 5 ft 7 in. The gauze has been placed at either 23 in or 44 in from the lower end of the tube. When the gauze is in position the tube is filled with a flammable mixture containing propane, ethylene, or town gas with oxygen and nitrogen and the mixture is ignited by a small flame applied to the lower end of the tube. The velocity of the flame near the gauze is measured with a drum camera and note is taken as to whether or not the flame passes through the gauze. There is a critical velocity of approach of the flame, below which the flame is quenched and above which it passes through the arrester. This critical velocity is similar for each of the three fuels but it increases as the mesh size of the gauze is diminished, so that the finer the gauze the faster it is able to quench a flame.

Substantial changes in the flame velocity can be obtained by altering the composition of the flammable mixture or by varying the length of the tube. With the short lengths of tube used in the tests the flame velocity increases markedly as the distance between the point of ignition and the arrester is increased. The dependence of the behaviour of the arresters upon the piping system in which they are installed is demonstrated by the results given below.

Tests with Single Layers of Gauze and Stoichiometric Propane-Air Flames.

Nominal mesh of gauze	Mesh width, in	Wire diameter, in	Material of gauze	Length of tube between ignition source and gauze, in	Number of tests made	Number of tests in which flame was arrested
28	0·021	0·015	Steel	23	12	11
30	0·023	0·011	Brass	23	12	11
30	0·023	0·011	Brass	44	12	0

The stoichiometric mixture contains 4 per cent of propane by volume in air; the mesh width is the size of the opening in the gauze.

When a number of layers of coarse gauze are built into a pack so that the meshes are accurately aligned, the resulting arrester is more effective in quenching a flame than a single layer of the gauze. When the number of layers exceeds four, however, the extra benefit obtained is considerably reduced. The combination of a fine gauze with one or two coarse gauzes is found to be less effective in arresting flames than is a fine gauze alone.

It is hoped to give a fuller account of this work later but already it is clear that the flame-quenching properties depend not only upon the dimensions of the apertures of the arrester and the composition of the flammable mixture, but also upon the dimensions of the system in which it is installed. Wire-gauze arresters have the disadvantages of mechanical weakness and low thermal capacity, so that, if a flame stabilises itself on the arrester, heating and the failure of the arrester can occur in a short time unless adequate preventive measures are taken. Further work is in progress, on gauze and other types of arrester, and information is being sought on the dimensions and functions of actual installations in which flame arresters are likely to be of value.

Acknowledgment.—The work described in this article forms part of the programme of the Joint Fire Research Organization of the Department of Scientific and Industrial Research and Fire Offices' Committee; the article is published by permission of the Director of Fire Research.

* Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization, Fire Research Station, Boreham Wood, Herts.

Construction

GOLIATH CRANE SAVES ERECTION TIME AT BRADWELL

Mechanisation in the form of cranes of one type or another is now a common feature on many sites where extensive construction work is in progress. The Goliath heavy duty crane which was seen in action for the first time on Wednesday, 19 March, is an outstanding example in more senses than one, for it is thought to be the biggest crane of its type in the world.

This overhead girder-type crane now stands astride the site of the nuclear power station under construction at Bradwell-on-Sea, Essex, and is a prominent landmark in the vicinity. It stands 177 ft high, about the same height as Nelson's column in Trafalgar Square, and spans the same distance. It is designed for lifting a maximum load of 200 tons deadweight, suspended vertically from the main hook, and also has an auxiliary hoist for a maximum load of 30 tons. Thus it is possible with this crane to lift a load the full clearance height of about 140 ft, to traverse the load across a clear span of some 170 ft, and to run the crane with its full load along 1,200 ft of track carried on strengthened foundations.

The Goliath-type crane which straddles the site for the Central Electricity Generating Board's nuclear power station at Bradwell-on-Sea, Essex. It is designed to lift, traverse and travel loads of up to 200 tons.

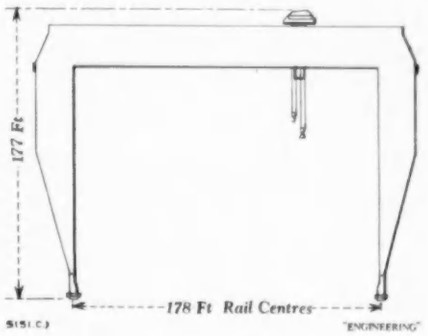
The commissioning of the crane marks an important stage in the progress of work on one of the first commercial nuclear power stations for the Central Electricity Generating Board. The building of the station, which will have two graphite-moderated gas-cooled reactors, was commenced in January, 1957, and the station is planned to be operating by December, 1960. Full advantage is being taken in this work of experience gained in the building of the Calder Hall reactors as regards the handling of such heavy components as boiler shells and the steel ring-segments of the spherical pressure vessels, where work on each reactor building had to be geared to progress in the construction and installation of these components. At Bradwell, the civil engineering work at each reactor site will be able to proceed independently, the six boilers and welded pressure vessel segments being installed, with the aid of the Goliath crane, at any convenient stage of construction.

It has been estimated that the time which will be saved by the use of the crane will be at least three months and may be as much as six months. Since at any time there may be employed on the site from 1,350 to 2,500 workmen, this represents a considerable saving in labour costs, which will more than compensate for the construction and installation costs of the crane, stated to be £400,000. The crane has been so designed that its bolted lattice-girder form of construction will enable it to be quickly dismantled and re-erected on another site.

From start to finish the design and construction has taken about 20 months, and the actual erection time seven months. It required 800 tons of mild steel and 43,000 high-tensile steel bolts and nuts. The steelwork was given two coats of paint at the works and the whole structure was re-painted after erection.

The structure consists basically of a pair of twin girders, carrying the normal type crab with two independent hoists, mounted on a pair of legs of similar construction. An interesting feature of the method of construction adopted was that the girders were assembled, with the aid of a small jib crane, on a high platform specially built for the purpose; the construction of these girders was independent of the leg structures which were later brought into position for the girders to be mounted. Correct load transfer was obtained by taking the vertical loads through pin joints. Deflection at the centre of the girders under a load of 200 tons was stated to be $\frac{3}{4}$ in and with a 250 ton load, $\frac{7}{8}$ in. The rear end of one leg is anchored to its corresponding girder while that of the other leg is left free to float; in effect this is a pendulum leg which can be made rigid when required. The base of each leg is pin-jointed to equaliser beams which distribute the load equally to eight four-wheel bogies which run on standard-gauge railway lines. The wheels and axles are also of railway pattern being made of rolled steel and running in phosphor-bronze bushed bearings.

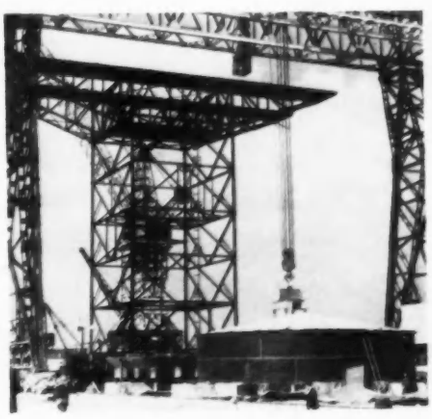
The crane is driven by electric motors supplied with direct current at 460 volts, which is provided by a 200 kW Crossley diesel generator



set located in a cabin carried by the structural members of one of the legs. Because of the structural vibration set up it is proposed at a later date to transfer this unit to a separate bogie. The crane is operated from a cage which travels with the crab. Travelling, traversing, and hoisting operations, are independently operated by means of a master reversing controller, which operates magnetic contactor gear. Two 50 h.p. motors enable the main hoist to be operated with a load of 200 tons at a rate of 4 ft 9 in per min and the auxiliary hoist, with a 30 ton load, at 33 ft per min. Standard crane hoist spur gearing is used, housed in totally enclosed steel gearboxes, with the shafts running on ball and roller bearings. The barrels, which are of rather large dimensions, are of steel tube construction machine grooved to avoid coil overlap. The speed of lowering on each hoist is governed by potentiometer dynamic braking. Eight motors, each rated at 20 h.p., provide the motive power for the bogies; four axles in each leg are driven through worm and spur gearing with coupling rods transmitting the drive from the geared axle to its mating axle in the same bogie. The movements of the legs are synchronised by a Selsyn control with the aid of an indicator in the crane cabin.

Automatic solenoid brakes are fitted to each hoist and two solenoid brakes are fitted to the transverse motion to hold the crab in position when the current is off. Normal braking is obtained by plugging through the control gear. In addition, storm clamps are provided to give further safe anchorage for the crane in a gale. In designing the crane, 5 lb per sq ft was taken as the wind load under the worst working conditions—the crane would not be operated in a wind of gale force.

The design and construction of the crane was by Clarke, Chapman and Company Limited, Gateshead (a member company of the Nuclear Power Plant Company Limited), in collaboration with Clyde, Crane and Booth Limited, Rodley, Leeds, and the Teesside Bridge and Engineering Works Limited.



The pair of twin girders which carry the crab were constructed on an elevated platform.

Continuing **Construction**

POSSIBLE SUBSIDENCE COUNTERED IN THREE NEW BRIDGES

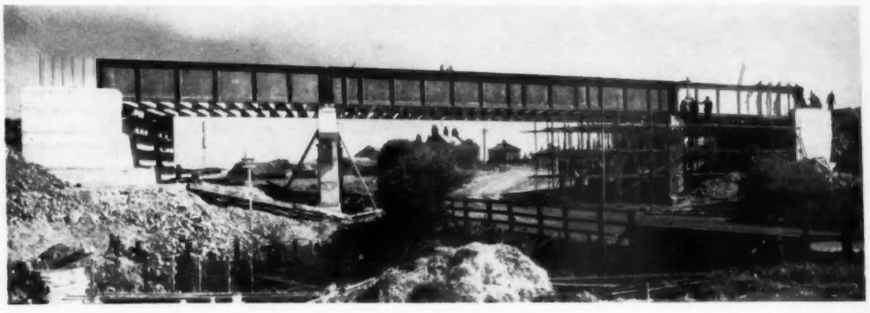
Three bridges recently completed for a new double-track railway in a north-eastern coal-mining area have been designed so that any movements due to settlement can be taken up by jacking either the piers or the bridge decks. All three bridges are skew and carry the new line over public roads. They have been built to British Railways full main-line standards, all details being approved by the Civil Engineer to the North-Eastern Region, British Transport Commission, at York. The new line is about 1½ miles long and connects to the main line at Woodhorn, near Newcastle upon Tyne.

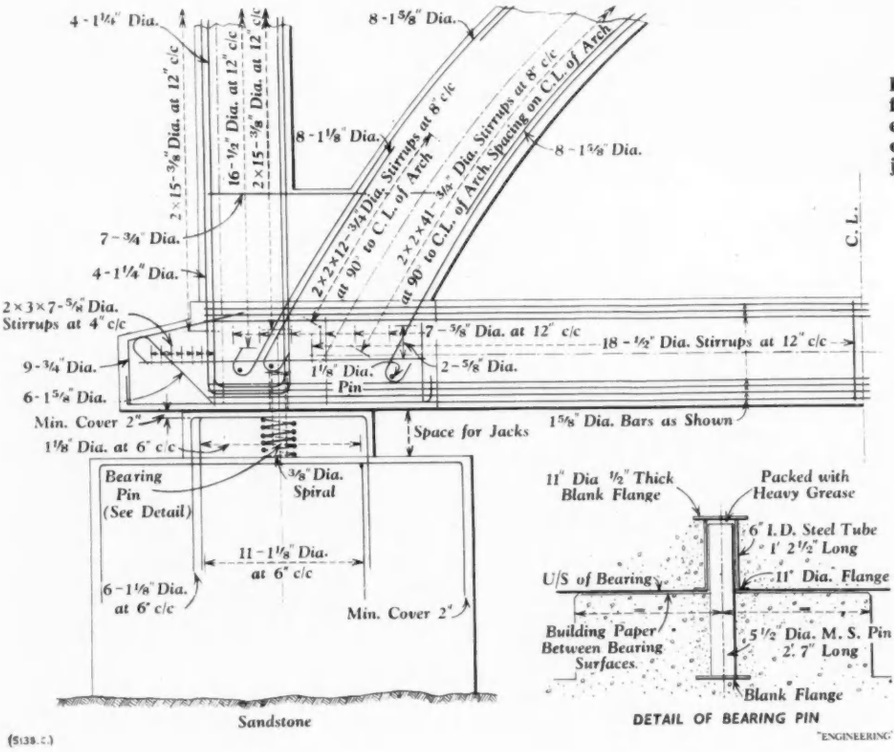
In their design, problems arose of both technical and aesthetic aspects. The technical problems were, in addition to that of possible subsidence caused by the mine-workings beneath, the very narrow margin available between the lower limit of road level, fixed by the County Council, plus Ministry of Transport minimum headroom, and the upper limit set by the running rail level which, in turn, depended upon the levels of the sidings at one end and the British Railways' line at the other. The aesthetic problem concerned only the middle bridge and arose because of its proximity to an old church.

The Planning Authority requested that the abutments and embankment ends be faced with York stone and that a suitable roughcast surface treatment be applied to the bridge structure, as shown in the top illustration. This requirement was satisfactorily met by encasing the steelwork in concrete to which a suitable sprayed surface was applied. This middle bridge of the three is also the largest, with a span of nearly 150 ft between abutments and an overall width of about 40 ft.

In this bridge a channel constructed across the face of each abutment contains a pre-cast concrete jacking beam which is free to be moved vertically upwards, being separated from the abutment by Flexcell joints. These beams carry the bearings for the three steel plate main girders. Two pockets are contained beneath each beam, into which 100 ton jacks can be inserted to raise the ends of the bridge if subsidence occurs under the abutments. The concrete arch supports at the " quarter points " of the span are constructed as separate entities from their foundation blocks, upon which they are each located by two vertical pintles of 5½ in diameter. Should either of these supports subside, then 200 ton jacks may be employed, below ground in this instance, between the foundation block and arch support. It can be

This through bridge carrying a double-track railway is in a coal-mining region and jacking points have been built into the abutments and below the intermediate piers so that any future settlements can be taken up. A steel girder bridge, to give a shallow depth of construction, it has been covered with rough-cast to harmonise with an old church nearby. A detail of the pier is given below.

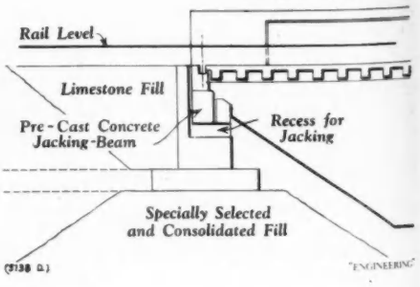



4 - 1¼" Dia.
2 × 15 - ⅜" Dia. at 12" c/c
16 - ½" Dia. at 12" c/c
2 × 15 - ⅜" Dia. at 12" c/c
8 - 1⅜" Dia.
8 - 1⅛" Dia.
2 × 2 × 12 - ¾" Dia. Stirrups at 8" c/c at 90° to C.L. of Arch
2 × 2 × 41 - ¾" Dia. Stirrups at 8" c/c at 90° to C.L. of Arch. Spacing on C.L. of Arch
8 - 1⅜" Dia.
7 - ¾" Dia.
4 - 1¼" Dia.
C.L.
2 × 3 × 7 - ⅝" Dia. Stirrups at 4" c/c
7 - ⅜" Dia. at 12" c/c
18 - ½" Dia. Stirrups at 12" c/c
9 - ¾" Dia.
6 - 1⅝" Dia.
1⅛" Dia. Pin
2 - ⅝" Dia.
Min. Cover 2"
1⅛" Dia. at 6" c/c
Space for Jacks
1⅝" Dia. Bars as Shown
Bearing Pin (See Detail)
⅜" Dia. Spiral
11 - 1⅛" Dia. at 6" c/c
6 - 1⅛" Dia. at 6" c/c
Min. Cover 2"
Sandstone
(5138 C.)

Elevation of the pier, and detail of the bearing pin, for the bridge in the above illustrations. In the event of subsidence, the whole pier can be raised on one or both sides from below ground level by jacks placed between the pier and the foundation pad.

11" Dia ½" Thick Blank Flange
Packed with Heavy Grease
6" I.D. Steel Tube 1' 2½" Long
U/S of Bearing
11" Dia. Flange
Building Paper Between Bearing Surfaces
5½" Dia. M.S. Pin 2' 7" Long
Blank Flange
DETAIL OF BEARING PIN
"ENGINEERING"

Section through abutment showing the positions of the recesses for jacks below the pre-cast jacking beams.



53 MILES OF MOTORWAY TO BE BUILT IN 19 MONTHS

Work began—officially—on the construction of the London to Birmingham motorway on Monday, 24 March. At a ceremony held at Slip End, near Luton, the southern terminus of the motorway, the Minister of Transport gave the signal for excavating machinery to start stripping the top soil. At a blast on a Klaxon horn a fleet of Caterpillar tractors and scrapers moved in on the task of transferring 14 million cu yd of spoil from the high to the low points along the 53 mile route, which is to be completed by October, 1959.

This is easily the most ambitious road scheme ever undertaken in the United Kingdom. John Laing and Son, the contractors, are faced with the task of preparing and laying a mile of 36 ft roadway every 5 days for the next 19 months—the period of the contract; towards the end laying the top surface will probably be at a rate of nearly a mile a day. The 150 bridges in the scheme have to be completed on an average of one every three days. Though there will be only nine intermediate connections with the rest of the road network of the country, there will be 200 or so fly-overs or underpasses of one kind and another.

Some £5 million of capital plant, including more than 1,000 major pieces, and around 3,700 men will be employed. Work has been divided into 20 separate sections, with a central administration compound at Newport Pagnell. Extensive use will be made of radio for overall control of the project and helicopters will be available for supervision. Also at Newport Pagnell will be a parts and spares service store established by Fred Myers, Limited, the London Caterpillar dealer who has supplied much of the earth-moving equipment.

More than 90 per cent of the motorway will have a gradient flatter than 1 in 50. The general construction depth will be 2 ft, comprising 6 in of compacted stone at the bottom, 14 in of either lean concrete or waterbound macadam (according to availability of materials), and a topping of 2½ in of tarmacadam as a base course with a wearing coat of asphalt 1½ in thick. The width of each carriageway will be 36 ft.

Special attention is to be paid to the appearance of the road. The Minister is being advised in this respect by a specially appointed landscape advisory committee and, at the ceremony, he observed that " this would be not only one of the best roads in the world, but one of the most attractive." At the southern end of the motorway will be the St. Albans by-pass, on which work has also just started. The by-pass will commence just south of St. Albans and will join the motorway at Slip End. From there the motorway will run north-west across the Midlands plains as far as Watford Gap, near Ashby St. Ledgers in Northamptonshire.

From there a short spur, to be built under the present contract, will branch off towards Birmingham and will join the Dunchurch by-pass (for which the contract is about to be let). The plan is to continue the main trunk northwards into Yorkshire. At intervals of about 12 miles along the route there will be service areas built on both sides of the motorway, with a footbridge linking the two halves. These areas will be for such facilities as petrol-filling stations, parking and picnic sites, transport cafés and restaurants (a nice distinction by the Ministry of Transport) and telephones.

The London-Birmingham motorway will be the first large-scale motorway to be constructed in the country and the first new national highway to be built in the present century. The value of the main contract is put at £15 million, representing an expenditure by the contractors of £125 per minute throughout the building period. Design of the road and of the bridges has been in the hands of Sir Owen Williams and Partners, the consulting engineers.

Also begun at the same time was the 12 mile St. Albans by-pass. This contract has been let separately to Tarmac Civil Engineering Limited. It will also be a double carriageway, though each road will be only 24 ft wide; it will be of lighter construction than the motorway, comprising 7 in of granular fill on which will be laid 11 in of reinforced concrete, placed in a single pass for the full 24 ft width of each pavement. The first task is to build an over-width section as a runway for aircraft which will bring machinery spares and personnel to the site.

Sir Owen Williams and Partners have designed 13 of the bridges required on the by-pass and the remainder by Col. C. N. ffolliott, M.I.C.E., county surveyor to Hertfordshire Council Council who are the agent authority to the Ministry in this case.

Continuing Three New Bridges

seen from the photographs that the main girders are discontinuous over the intermediate supports and it is thus possible, with no residual distortion, to restore the bridge to its original levels from any one or more of the eight jacking positions which have been provided.

The consultants designed this as a steel bridge because the small construction depth available for the deck made the employment of upstand girders essential. With these girders in steel plate, a rapidly-assembled thin deck was possible, using concrete-encased rolled steel joists resting upon the lower flanges. The two outer girders are 75 in deep by 24 in, the intermediate girder being 90 in deep by 24 in; the reinforced-concrete decking was cast *in situ* upon the encased 12 in by 7 in R.S.J.s and the deck was completed by laying quarry tiles upon a bituminous waterproof membrane.

The other two bridges are constructed with prestressed concrete beams laid side by side across the abutments and tied at the supports by *in situ* concrete jacking beams which have the same function as the similar beams in the bridge described above. The photograph of the single-span bridge shows the recesses for the jacks just below the deck beams. The beams were pre-cast in a special casting yard set up by the contractor adjacent to one of the bridges. For prestressing, Macalloy bars were used which could only be tensioned when a minimum concrete strength of 5,000 lb per sq. in had been obtained, the mix was required to give 7,000 lb per sq. in at 28 days; to enable work to proceed quickly, the contractor equipped the yard with a steam-curing plant. By this means the necessary strength was developed in 16 hours after casting and enough bars could then be inserted and tensioned to enable the beams to be lifted and placed in a storage area.

The smaller bridge has a span of 35 ft constructed with 18 I-beams 26 to 27 in deep by 18 in laid side by side. Each beam contains five Macalloy bars of 1⅛ in diameter tensioned to 32¼ tons. The holes for these bars were preformed using Ductubes and cast straight against a 2⅜ in camber to the beam soffit; this method was preferred to the alternative of parabolically cast holes with straight beams. The 16 inner beams were transversely prestressed at approximately the " third points " with Macalloy bars tensioned to 12 tons each. The two outer beams were then positioned and the pre-cast parapet counterforts and panels were fixed above them. The larger bridge has a clear span of 55 ft and has 22 I-beams 42 to 45½ in deep by 15 in with a 6 in camber to the soffit. Each beam contains six Macalloy bars of 1⅛ in diameter tensioned to 32 tons; the 20 intermediate beams are transversely prestressed similarly to the smaller bridge.

Although all the bridges are across public roads, it was only necessary to close them for a short period while the main beams or girders were being placed in position; other work, such as deck concreting, which might otherwise have caused inconvenience, was carried out at night.

The main contractors for this work were Holloway Bros. (London) Limited, Millbank, S.W.1; the steelwork for the one bridge was fabricated and supplied by Dorman Long and Company, Limited, Middlesbrough. The consulting engineers who designed and supervised the construction of the work were Posford, Pavry and Partners of Abbey House, Westminster.

One of the smaller, single-span bridges, showing the jacket pockets left in the abutments to enable the main girders to be lifted if subsidence occurs below the bridge. The main girders are of prestressed concrete, with straight cables but a cambered soffit.

RESILIENT BLACK TOP

A report just received from Australia states that Western Junction Airport, at Launceston, Tasmania, is the latest Australian airport to adopt rubberised bitumen for sealing airstrips. The surface was in a bad condition before treatment. Both latex and a fast dissolving rubber powder were used. This follows the successful use of the material at Melbourne Airport, at Sale, Essendon and elsewhere.

The mixture used at Melbourne consisted of 80/100 bitumen cutback with asphaltic oil, together with 1½ per cent. and 2½ per cent. of rubber powder, used in two separate experiments. Sections of the strip were resealed with ordinary bitumen for comparison. Two years later, the rubberised bitumen sections were still in excellent condition whereas those without rubber had cracked, allowing water to penetrate and weaken the underlying pavement.

Book Reviews

BOOKS ABOUT TRANSISTORS

The flood of publications on transistors continues to increase as more and more engineers discover that the transistor presents a convenient solution to many of their problems. There is a great demand for information on all aspects of transistor techniques and as the large number of books under review (ten) indicates, efforts are being made to supply this need.

Half the books reviewed have originated in the United States where the transistor was invented; four of the others are by British authors and the remaining one is a collection of papers by an international selection of authors.

Comparison of the prices shows that books published in the United Kingdom are still cheaper than those published in other countries. When considering a mixed batch of books as in this case, price cannot, in fact, be taken as a true indication of worth. Indeed, some books reviewed below, priced at a guinea or under seem to be technically of a higher standard and are more useful than others costing five times as much.

Transistor Circuits and Applications. By JOHN M. CARROLL. *McGraw-Hill Book Company Incorporated*, 330 *West* 42*nd Street*, *New York* 36, *N.Y.*, *U.S.A.* (7·50 dols.); and *McGraw-Hill Publishing Company Limited*, 95 *Farringdon Street*, *London*, *E.C.*4. (56*s.* 6*d.*)

This book is a collection of 106 articles published in the American magazine *Electronics* between 1950 and 1956.

Many of these articles report developments when the transistor was a new device, and have largely outlived their usefulness. Most of the articles are concerned with specific applications of transistors, and many describe particular equipments. In many cases the circuit details provided are not sufficient for the book to be useful as a handbook of circuits. Nor is it to be recommended as a book for the beginner, despite its historical interest, since there is little correlation between the various articles.

The historical interest includes a table of all the transistor types which were available in America in late 1955.

Transistor Engineering Reference Handbook. By H. E. MARROWS. *John F. Rider*, *Publisher*, *Incorporated*, 116 *West* 14*th Street*, *New York* 11, *N.Y.*, *U.S.A.* (10 dols.); and *Chapman and Hall Limited*, 37 *Essex Street*, *London*, *W.C.*2. (80*s.*)

Most of the book is devoted to assembling data on 200 transistor types, of which only three are British. The main use for this type of work would be as a means of rapid comparison of transistor characteristics for the circuit designer, but unfortunately this is almost impossible, as the book is made up of facsimile reproductions of manufacturers' data sheets, and there is no uniform system of presentation. Each manufacturer has his own idea of which parameters to quote, and at which operating points to make his measurements.

Components suitable for use in transistor circuits are also listed, but again comparison is often difficult due to the differences in presentation between manufacturers' lists. There is a useful but short survey of transistor materials, structure and fabrication techniques, but on the whole it is difficult to see the reason for publishing this book outside North America.

Transistor Circuit Engineering. Edited by RICHARD F. SHEA. *John Wiley and Sons Incorporated*, 440 *Fourth Avenue*, *New York* 16, *N.Y.*, *U.S.A.* (12 dols.); and *Chapman and Hall Limited*, 37 *Essex Street*, *London*, *W.C.*2. (96*s.*)

This book, of American origin, sets out to be a comprehensive design manual of transistor circuits. Eight authors have contributed to the book, and so there is a certain amount of overlap and omission between the various sections.

The first chapters are on characteristics, followed by equivalent circuits and biassing techniques. Following these are several chapters on amplifiers, including audio, directly coupled, tuned, and video applications after which come sections dealing with oscillators, frequency changing, and associated problems. After a chapter on pulse circuits the book proceeds with a section entitled " Systems " which is really an outline of the applications of transistors to radio and television. The last chapter describes some miscellaneous circuits which have failed to find a place in other parts of the book.

In general, the circuits described seem to be basically sound, but most of them would require considerable development before being put into use in equipment. The book is fairly easy to read, although its style makes the subject appear rather more difficult than it actually is; unfortunately, it is left to the reader to discriminate between important and trivial design criteria in a number of cases.

An Introduction to Junction Transistor Theory. By R. D. MIDDLEBROOK. *John Wiley and Sons Incorporated*, 440 *Fourth Avenue*, *New York* 16, *N.Y.*, *U.S.A.* (8·50 dols.); and *Chapman and Hall Limited*, 37 *Essex Street*, *London*, *W.C.*2. (68*s.*)

The dust jacket claims this book to be " A thorough background for the electronic engineer who is interested in the ' how ' and the ' why ' of transistor operation."

After a brief introduction to the transistor as a device the book gives first of all a simple qualitative non-mathematical account of junction transistor theory, which is then amplified in further chapters dealing with semiconductor physics. Having described in detail the action at a *p-n* junction the author then combines two junctions to form a *p-n-p* transistor, which is then exhaustively analysed. Most transistor phenomena are covered in this treatment, which eventually leads to the construction of equivalent circuits whose complexity varies according to the number of effects which are to be accounted for. Finally some secondary effects are considered which modify the basic theories of transistor action.

Although sections of the book are inevitably rather mathematical in character, at no stage is the book difficult to follow, and it contains no more than the minimum of mathematics necessary to cover this aspect of the semiconductor field.

Certain subjects such as drift transistors and collector breakdown phenomena, which would be of interest to the class of reader for whom this book is intended, have been omitted, but nevertheless the book satisfies a long-felt want for the not-too-complex analysis of the ordinary junction transistor, and in the main the aims of the book seem to have been achieved.

Progress in Semiconductors. Vol. 2. Edited by ALAN F. GIBSON. *Heywood and Company Limited*, *Ingersoll House*, 9 *Kingsway*, *London*, *W.C.*2. (63*s.*)

This book, which is one of an annual series, is a collection of papers by specialist authors, and is mainly of interest to the semiconductor physicist. Each paper constitutes an up-to-date review of developments in a particular topic, and is designed to enable the specialist to keep abreast of his subject. Annual publication enables the editors to ensure that the very latest work can be reported.

There are eight papers, covering:

Semiconductor alloys.
Properties of the III-IV compound semiconductors.
Radiation effects in semiconductors.
Lifetimes of free electrons and holes in solids.
The production of high quality germanium single crystals.
Impurities in germanium.
High electric field effects in semiconductors.
Theories of electroluminescence.

The papers are of a uniformly high standard, as might be expected from the leading workers in this field, and are understandable to the non-specialist. However, they are not for the beginner.

The book's usefulness might be enlarged by the inclusion of summaries directed at the non-specialist, enabling him to decide whether he should read the full paper, and also to obtain an outline of the trends in a particular topic without having to cope with the details. The presentation and production of the book is of the highest order.

Fundamental Principles of Transistors. By J. EVANS. *Heywood and Company*, *Tower House*, *Southampton Street*, *London*, *W.C.*2. (45*s.*)

An Introduction to Semiconductors. By W. CRAWFORD DUNLAP, JNR. *John Wiley and Sons Incorporated*, 440 *Fourth Avenue*, *New York* 16, *N.Y.*, *U.S.A.* (11·75 *dols.*); and *Chapman and Hall Limited*, 37 *Essex Street*, *London*, *W.C.*2. (94*s.*)

Much recent work on semiconductors is reported usually in considerable detail in articles and papers scattered over a wide range of journals and proceedings, and a book which can gather together the salient features without getting the reader immersed in details (which may be obtained, if necessary from the original papers), is therefore likely to appeal to a large class of readers.

The two books under review, one American and the other British, have both been written with this end in view, but naturally there is a considerable difference of opinion as regards the amount of detail which may be left out without loss of usefulness.

The book by Dunlap is aimed at a rather wider readership than that of Evans. A considerable amount of the book (about a third) is devoted to semiconductor theory, starting with an account of crystal structure, and proceeding by way of solid state theory and a consideration of crystal imperfections, to the statistical mechanics and the electron theory of metals and semiconductors. The contact and surface properties of semiconductors, and the properties of *p-n* junctions are also dealt with. The rest of the book is concerned with the more practical aspects. There are chapters on experimental measurements on semiconductors, and the general methods of preparing semiconductor materials, followed by an account of the properties of semiconducting elements and compounds.

Here the whole range of semiconducting substances seems to have been covered, in sharp contrast with most books on the subject which usually confine themselves to germanium and silicon only. The remaining chapters of the book describe practical applications of semiconductors; rectifiers, transistors, thermistors, photocells, the Hall effect, etc.

The amount of detail which has been retained, and also the wide scope of the book, suggests that it will in fact be more useful to those setting out to widen their knowledge of semiconductors preparatory to embarking upon some advanced work on the subject rather than to a person who wants a first introduction to the field. In this respect the book fulfils the aims expressed in the preface, although the title is rather misleading.

By way of contrast, the book by Dr. Evans is restricted to consideration of the properties of germanium and silicon, and the theory of semi-

conductors is disposed of simply, but very adequately, and without the need for mathematics in the first chapters. Following this comes a chapter on measurements of semiconductor parameters, which serves to amplify parts of the first chapter by tying sections of the theory to actual measurable physical facts. Then follow accounts of the theory and methods of preparation of *p-n* junctions.

Other chapters go on to describe junction and point contact transistors, measurements of their parameters, and their manufacture. Finally special types of transistor are described, and the book ends with a short account of the use of silicon in transistors and mention is also made of other semiconducting materials.

This book is admirably suited to provide a first introduction to the field of semiconductors and, at the same time, the inclusion of much up-to-date information from a wide range of original papers ensures that the reader is quickly brought abreast of current practice.

The omission of any mathematics bias does not detract in any way from the usefulness and accuracy of the book, as in all cases adequate references are made. In fact, the absence of mathematics makes the book one of the most readable that has appeared in the transistor field for some time.

A comparison of the two books seems to indicate that Dr. Evans's work contains the most information regarding transistors in immediately assimilable form, but as a reference book for quantitative knowledge over a wider field, that by Dunlap is likely to find more use amongst advanced workers. In fact the two books to some extent complement each other, the one illuminating some aspects which may be met in the other.

Transistors: Circuits and Servicing. By B. R. A. BETTRIDGE. Published for "Wireless and Electrical Trader" by *Trader Publishing Company, Limited, Dorset House, Stamford Street, London, S.E.*1. (2*s.* 6*d.*)

This booklet, which is written mainly for the radio service engineer, describes very simply some of the physical properties of transistors and their modes of operation. Some typical applications in radio receivers are mentioned, and servicing hints and methods of testing transistors are included. The circuit for testing a transistor for current gain and leakage current might prove expensive in milliameters if a short-circuited transistor were encountered, as there is nothing on the diagram to refer one to the relevant sentence in the text regarding meter overload protection. Apart from this, however, the booklet contains some sound information to guide the service engineer.

Transistor A.F. Amplifiers. By D. D. JONES and R. A. HILBOURNE. Published for "Wireless World" by *Iliffe and Sons, Limited, Dorset House, Stamford Street, London, S.E.*1. (21*s.*)

Books on transistors usually attempt to cover such a large portion of the art that each topic receives a rather superficial treatment. In the present instance, however, the authors have set out to deal in considerable detail with one field of application of transistors, namely their use in A.F. amplifiers.

Although the book starts off with the inevitable introduction to transistor characteristics, this section is short enough not to bore the specialist and yet contains a large amount of information for the non-specialist. The algebra is mercifully reduced to a minimum.

The design of small signal amplifiers is then described, problems such as noise being dealt with as they arise in the course of the treatment. Following this is a similar chapter on the design of power amplifiers, which presents a considerable amount of data that has not hitherto been readily available.

Having thus disposed of design theory the authors continue with more practical chapters which describe in detail typical designs of pre-amplifiers, Class A power amplifiers and Class B power amplifiers. Circuit values and practical data are given in all cases for several complete amplifier designs.

By restricting the scope of their book to a fairly narrow field, the authors have been able to deal with their subject in a fair amount of detail. Their style is easy to follow and the book is likely to find a considerable following among the not-so-technical enthusiast, who will appreciate the complete amplifier designs, as well as with the professional engineer, who will be more interested in the design data.

One or two minor points in some diagrams may not be immediately obvious to the reader.

An Introduction to Transistor Circuits. By E. H. COOKE-YARBOROUGH. *Oliver and Boyd Limited, Tweeddale Court, High Street, Edinburgh*, 1. (15*s.*)

Although of only 154 pages, and therefore of a very modest size by current standards, this book manages to include a great deal of the transistor field between its covers. The author has not attempted to write a comprehensive textbook on transistor circuits, but has instead devoted his efforts to building up a physical picture of transistor operation and then gone on to show how transistor circuits can be analysed and developed using this approach.

A large part of the book deals with non-linear circuits; here the superiority of the author's approach compared with the conventional small-signal method is evident. Too many books on transistors have analysed linear circuits by small-signal methods at great length and then included a short chapter on pulse circuits as an afterthought.

The book commences with a chapter on transistor action which is remarkable for the manner in which a comprehensive picture of semiconductor phenomena is built up from elementary concepts with an almost complete absence of mathematics but with no loss of accuracy. The chapter on low frequency amplifiers which follows shows that a knowledge of the physical actions in a transistor can yield an accurate equivalent circuit, which is in fact the classical T equivalent circuit. This equivalent circuit is used to bring out the salient features of the three basic ways of connecting a transistor amplifier.

The next chapter, on the performance of transistor amplifier circuits deals rather more deeply with transistor amplifiers, such effects as frequency response and collector capacitance being considered. The remaining three chapters, comprising the other half of the book, are devoted to pulse circuits and other non-linear applications, and include a chapter on computer circuits.

The non-linear circuits are described in considerable detail, and the value of the approach from physical principles is clearly seen when, for instance, carrier storage is considered.

Both junction and point-contact transistor circuits are dealt with, and the author has wisely adopted two different symbols to enable the reader to discover immediately the type of transistor which is being used in any given circuit. Also by adhering to the convention of positive current flow being in the downward direction in all cases, the confusion which a newcomer to the field experiences when confronted with strange symbols and a strange current convention, as so often happens with books on transistors, is largely eliminated.

The book should have a wide appeal to many classes of reader: the student, the engineer entering the transistor field, the transistor engineer who seeks to refresh his outlook and his grasp of the fundamentals should all benefit from this book. The lists of references at the end of each chapter have been carefully chosen.

The production is of a high order, although the scale of some diagrams appears to be a trifle large, and this, combined with the generous size of type often results in much turning over of pages when comparing a diagram with the relevant text.

Perhaps these points will receive attention in the second edition; it seems fairly safe to assume that there will be one, as the book shows all the signs of becoming a standard work.

On the Shelf

By Frank H. Smith

The Institute of Advanced Legal Studies' tenth annual report (1956-57) is almost entirely of library interest. In ten years of existence a library of well over 50,000 books has been built up and a world-wide reputation has been acquired. During 1957 a union catalogue of holdings in British libraries was published in its second edition. This was twice the size of the previous edition, published in 1949, and covers over one thousand periodicals in 76 libraries. If this seems a large number of legal libraries, it should be pointed out that libraries other than those devoted to law take legal publications.

The report on library working tells the same tale as for every other library. Increases in acquisitions, loans, telephone inquiries and the rest of the librarian's daily "stint." Only one thing in the library world decreases each year—accommodation. To this there is one reasonable solution and that is micro-reproduction. One assumes that a decrease in printed material is not a reasonable solution.

In my comments on the annual report of the American Society of Mechanical Engineers I remarked that there seemed to be no mention of the library. This is probably on account of the set-up with the combined engineering societies, as I see there is a summary of the annual report of the United Engineering Trustees Inc., in the February *Mechanical Engineering*. In this report the library figures are given in remarkable detail. For instance, a figure is given for translations and a quite separate item for words translated. It would seem that the Engineering Societies' Library has reached a peak, or rather a plateau, since the figures for 1956/7 show a comparatively small increase on those for 1955/6, with the exception of bibliography orders, which, for some peculiar reason, have dropped by nearly 50 per cent. There is a little significant remark in the comment on the library's paid services. These, it appears, while still showing a slight increase have nevertheless "tapered off somewhat from that of previous years. The use of the library's paid services is always closely related to business conditions." Somebody, at any rate, realises that things are not what they were.

It is awe-inspiring to note that the Engineering Societies' Library now musters 175,000 volumes and 1,500 periodicals besides other astronomical figures for things like maps, bibliographies and translations. Another interesting little extract reads "For years the Library has received a few Russian periodicals, but others that were wanted were not obtainable. This situation changed recently; therefore members of the staffs of the Library and the Engineering Index selected ten additional Russian periodicals."

The Library Association has "gone all contemporary" in one sense by producing Bibliography No. 24 on "The Channel Tunnel." It has been compiled by Mr. Harold Smith, of Kensington Public Libraries. He has managed to dig up 244 items (of which quite a number are from a very distinguished journal) and the list is preceded by an introduction by a Mr. S. L. Solon—an American who has made the Channel Tunnel his special study. The list costs 2*s.* 6*d.* from the Association, Chaucer House, Malet Place, London, W.C.1.

Anybody interested in Dutch aluminium can lose nothing by asking N.V. Nederlandsche Aluminium Maatschappij, Postbus 2020, Utrecht, for their "Tabellen en andere gegevens over aluminium: en aluminium-legeringen." I do not understand Dutch (it is as much as I can do to understand English sometimes) but the pamphlet looks very much like those publications that the Aluminium Development Association produce in this country, in which all the virtues and applications of various alloys are conveniently tabulated.

Design

GAMMA RADIOGRAPHY

Comparison of British and Soviet Equipment

Non-destructive testing using radioactive isotopes as sources of gamma radiation has been widely applied in this country and elsewhere. The author of this article, who has been specially concerned with these techniques, has had the opportunity to study both British and Soviet radiographic equipment, and has prepared the following comparison.

The purpose of these notes is to compare very briefly certain trends in the development of radiographic techniques in Britain and the U.S.S.R. An indication of the practical applications and methods used in both countries is given by a comparison between types of equipment available. The British equipment described here is that produced by Nuclear Engineering Limited, of Greenwich, but other equipment of equal merit is produced in the United Kingdom, though it is not discussed here. A great deal has been published in both countries on the theoretical basis of the various techniques used and on practical requirements for X-ray films, dark-room techniques and other procedures. None of these aspects form the subject of discussion in this report.

It is now usual practice in the erection of large industrial and chemical plants, where equipment is intended for heavy duty, to provide extensive radiographic inspection of those parts where faults are most likely to develop, for example weldings, forgings, castings and, in some instances, the original ingots or billets from which heavy plate and other items are made. The British Standards Institution, Lloyd's, and other insurance companies, and, in the U.S.S.R., the State Inspection Committee, all lay down schedules of minimum specifications for the purpose. The inspection departments of large industrial corporations in the U.S.S.R. have their own regulations and detailed methods of inspection, as do some large organisations and Government departments in Britain. However, it is well known that the handling of radioactive isotopes introduces certain hazards and equipment is required for containing and remotely manipulating these materials. The apparatus illustrated in this article is all designed for that purpose, and in particular Figs. 1 and 2 show British and Soviet mechanisms for remote manipulation.

In both countries it is generally appreciated that radiography is a useful and adaptable method of non-destructive testing, which is frequently the only practicable method of providing a reliable test and a permanent record at low cost. It is often cheaper to invest in an extensive series of radiographs than to run the risk of breakdown in a large plant, aircraft, or ship, as the result of defective material or bad workmanship.

In general in both countries the advantages of industrial radiography are considered to be the following: (1) safeguard against costly breakdowns, due to hidden faults in manufactured products; (2) permanent record of all tests available for future reference; (3) non-destructive inspection applicable to a wide range of products without serious interference to production; (4) aids the development and simplification of manufacturing operations by providing a picture of the internal conditions in an assembly; (5) assists in the quality of routine production; (6) enables economies in raw material to be made by providing an indication of quality and homogeneity; (7) is a useful aid in developing and

REMOTE HANDLING OF RADIOACTIVE ISOTOPES

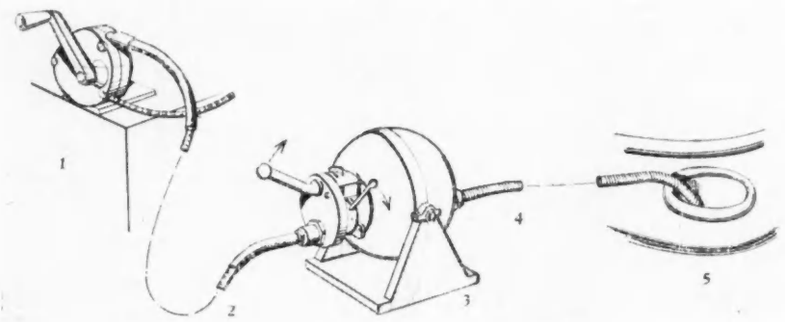


Fig. 1 British equipment for remote operation of radioactive isotopes (at a distance 12 to 35 ft): the Pentatron system designed by Nuclear Engineering Limited. All British plant illustrated is made by this company.

1. Remote control box.
2. Geared cable.
3. Isotope container.
4. Guide tube for distances up to 60 ft, leading to the terminal 5.

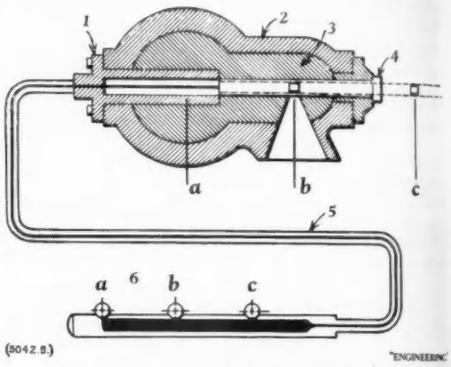


Fig. 2 Soviet remotely controlled radiographic unit GUP Co 0·5.

1. Portable container.
2. Iron cast shell.
3. Lead shielding.
4. Plug (manually operated from about 2 to 3 yards distance).
5. Cable.
6. Crank for control of hose, to move the source about 4 to 6 in outside of the storage container.

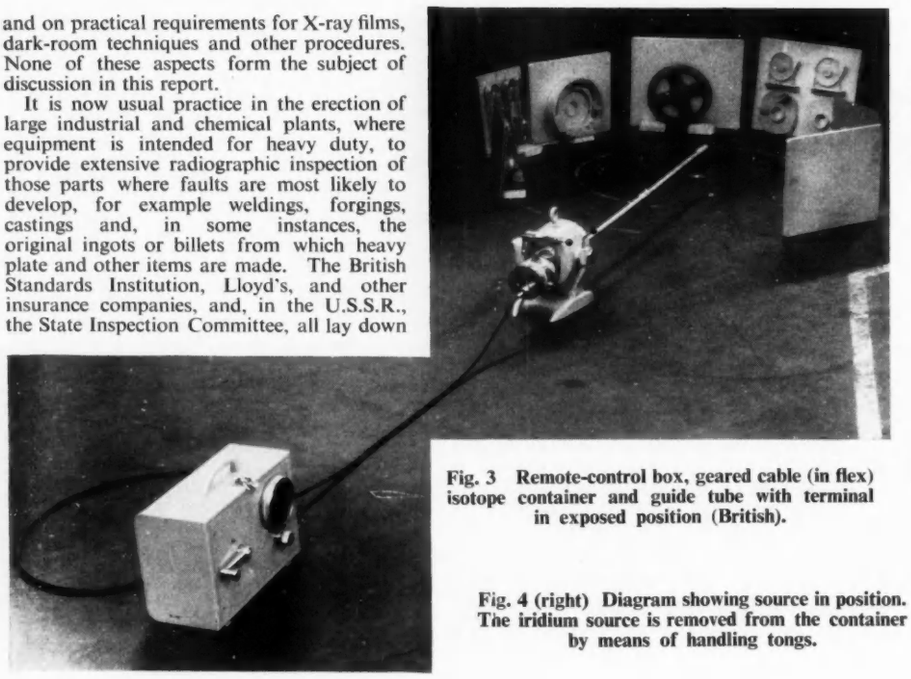


Fig. 3 Remote-control box, geared cable (in flex) isotope container and guide tube with terminal in exposed position (British).

SIMULTANEOUS RADIOGRAPHY OF SEVERAL ITEMS

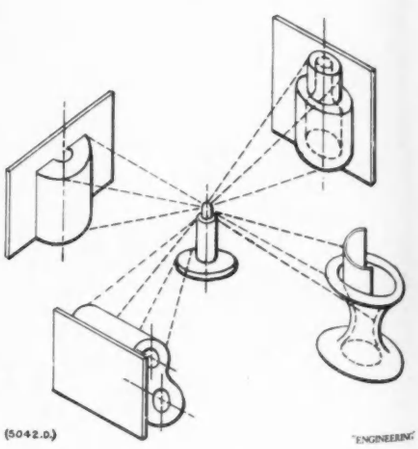


Fig. 4 (right) Diagram showing source in position. The iridium source is removed from the container by means of handling tongs.

maintaining a high standard of workmanship in some skilled personnel, as for welders; and (8) each individual specimen can be tested—it is not necessary to rely on statistics and probability theory.

To those aspects of radiography which are generally recognised in the Western Hemisphere as important, there may be added one which is considered particularly important in the U.S.S.R. In general, quality of workmanship is proportional to the amount of care and interest shown in a job. Initial enthusiasm has a limited life and periodic inspection gains in importance as time progresses. The knowledge that work will be regularly inspected by radiography for hidden faults frequently has beneficial results in most metallurgical industries in the U.S.S.R. The fourth and fifth five-year plans in the U.S.S.R. brought into Russian industry a considerable amount of rural labour. Speedy and thorough training was an important factor in the integration of partly skilled or theoretically educated labour. Here radiography has been and is being used as a training tool for quality workmanship, and is normally taught in training centres.

The metal-working industry in the U.S.S.R. is concentrated in large combines, since the small and medium-sized organisations common in British industry are considered by the Russians to be uneconomical. Radiography in a large Russian combine is carried out by a special well-equipped inspection department which frequently acts as a training centre in the manner indicated above. Although small and medium-sized British firms who are traditionally quality-minded have taken up the use of radiography as an inspection tool for quality control, it is surprising to note how few of the larger companies and combines, who might have been expected to have large inspection departments, have done so. In consequence of this the bulk of British gamma radiographic equipment is used in workshops of the smaller and medium-sized companies. It is, therefore, important that a workshop tool should be robust, capable of rough handling, simple in operation, and efficient. The minimum of servicing should be required under normal circumstances, and an intelligent layman should be able to use it safely and efficiently. The scene in the U.S.S.R. is, however, vastly different; most of the equipment is used by special departments of a " laboratory " set-up even when the equipment is used on the workshop floor.

The science of " Defectoscopy," as industrial radiography is called in the U.S.S.R., is a subject on which a large number of Russian trade periodicals regularly publish articles. One popular handbook (*Kontrola Kachestva Metallov Gamma Luchami*—Quality Control of Metals by Gamma Rays) has run through a first edition of 6,000 copies. In addition, numerous Russian societies and institutes reprint lectures, instruction, regulations, and other material, which find a wide circulation.

Table I, page 446, indicates the types of sources most commonly used for radiographic purposes in both countries. The use of radon in Britain is very small at the present time, largely owing to its high cost and very short half-life. For special purposes it may still be very useful as a high activity can be concentrated into a very small volume and hence provide a good quality radiograph. Tantalum 182 is also little used here since its radiation is similar in quality to that of cobalt 60 which has a much longer half-life. Its only advantage is that higher specific activities may be obtained than for cobalt 60 in a given time of irradiation. Europium 152 is a separated fission product which is very expensive and in short supply. It is available in Britain for research purposes but not at the moment in activities suitable for practical radiography. Thulium 170 is being used more and more but is so far only available in small quantities from Harwell. Iridium 192, caesium 137 and cobalt 60 are in widespread and expanding use to-day.

From comments made at the last International Conference on the Peaceful Uses of Atomic Energy, at Geneva, it appears that all the sources listed below are in use in Russia though it was not possible to obtain firm indications of their relative use. It may be inferred that the same considerations that apply to Britain would tend to concentrate interest on cobalt, iridium and caesium. Table II provides an indication of the relative distribution of cobalt 60 sources for different purposes in Britain and the U.S.S.R. The Russian interest in the use of radioactive isotopes in education and training is evident.

A comparison in techniques used may be more illustrative. A useful attribute of gamma radiography is that a radioactive source emits rays equally in all directions, thus allowing, under ideal conditions, the useful employment of a whole sphere of radiation. This is amply demonstrated by the panoramic type of set-up used in many foundries. Here the castings to be examined are arranged in a circle around the source and the radius of the circle is adjusted to give the exposure and definition required. Where a group of dissimilar castings are to be examined, the source-to-film distance of each casting may be adjusted independently to allow for the effect of the variations in thickness on the exposure and all may be radiographed together. The basic technique used here may be seen clearly from Figs. 3 and 4.

In the British equipment illustrated the radiographic container is placed in any suitable spot and the operator drives the radiation source from a safe distance into the required exposure position through a pre-set guide tube. The most intricate positions (even for under-water work) can be achieved, for the source can be driven out from a distance to a pre-set point by remote control and the equipment used in complete safety.

The Russian low-radiation-intensity equipment seems to be of a simpler design. (In the U.S.S.R. sources are classified as low-intensity and high-intensity sources. The low-intensity sources are considered to be iridium, caesium, thulium and europium. High-intensity sources are cobalt, tantalum and radon. Equipment for use with these sources is classified accordingly.) Protective shielding with an appropriate cavity and handling tongs form one group and an X-ray type of equip-

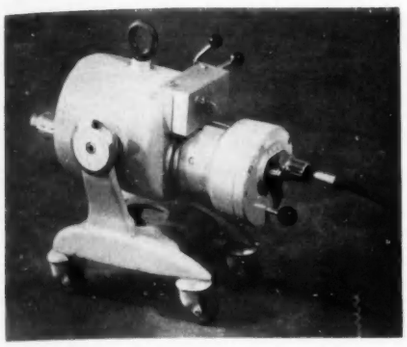


Fig. 5 British TR1000 portable radiographic unit suitable for thulium 170 of any strength (single source unit), and designed for the electronic and allied industries.

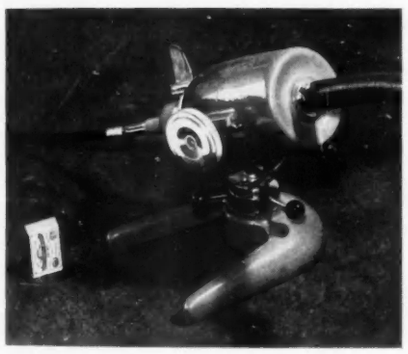


Fig. 6 British mobile caesium CSR1000 radiographic unit, holding two sources: caesium 137/thulium 170 or iridium 192. It is designed for inspection of chemical plant.

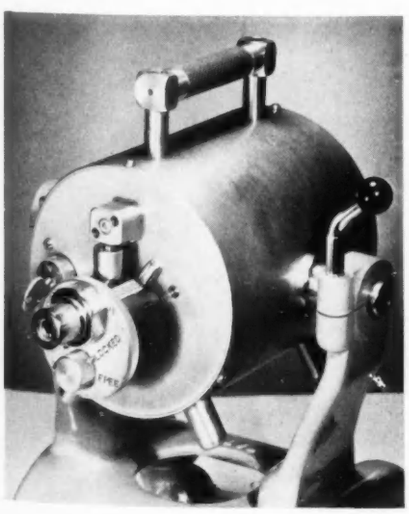


Fig. 7 (left) British portable iridium radiographic unit, made in tungsten alloy for highest degree of safety. It is designed for use in foundries and welding shops by professional radiographers.

LOW-INTENSITY EQUIPMENT

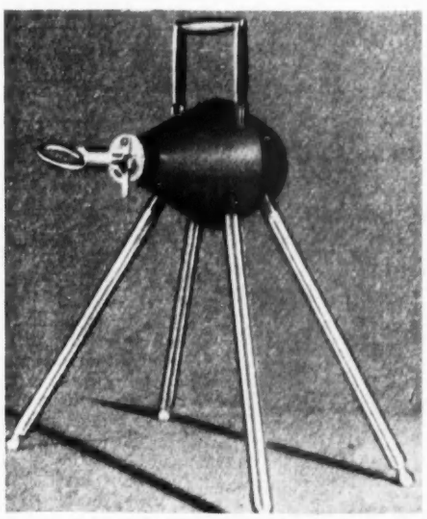


Fig. 8 Portable iridium or caesium radiographic container made in the Soviet Union. Source is removed by means of handling tongs.

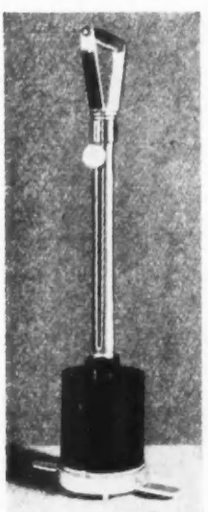


Fig. 9 (right) Portable Soviet iridium or thulium container. The handling tong is also used as a carrying handle.

Continuing Design

ment with a shielded storage head (instead of an X-ray tube) the other. For a panoramic set-up, the source is either withdrawn with the handling tongs and placed in the centre of the set-up (see Fig. 4) or projected a few inches from the storage head (GUP 0·5). In the low-intensity range few, if any, safety precautions are incorporated in Russian equipment. Simple containers with manipulation by handling rods are generally used; the comparative photographs illustrate. A comparison of British and Soviet low-intensity apparatus appears in Figs. 5 to 9.

The second group of Russian equipment is in the high-intensity class. British and Soviet high-intensity equipment is shown in Figs. 10 to 13. The mechanism of the Russian high-intensity unit, the GUP 50, is similar in principle to a radium therapy unit which has been in use in British hospitals for many years. From a storage box (lead lined), the source is blown through a tube into the exposure head by means of compressed air. Return of the source is achieved in the same way. (Up to 0·5 curie of cobalt 60 is also used in the low-intensity type of containers adapted with a simple cable exposure control.—GUP 0·5.)

The design of this Russian cobalt radiographic equipment appears to follow very closely that of the orthodox X-ray unit and does not take advantage of the possibilities of producing a small compact apparatus. It is probably designed by experts working in laboratories, for laboratories. The appearance of the GUP Co 0·5 and GUP Co 50 is that of an X-ray apparatus with very little outward signs of modification. It would seem, therefore, to possess all the disadvantages of the X-ray set, being large and cumbersome. The design is essentially similar in form to the original medical diagnostic apparatus suitable for laboratories.

The British isotope radiographic container of to-day is, on the other hand, basically a shop floor item where the prime need is for safety, robustness and simplicity rather than the fine control of horizontal and vertical movements so necessary on medical and laboratory equipment. The two main Russian pieces of equipment seem to be developed directly from X-ray units, whereas British gamma radiographic equipment has been designed from scratch primarily for workshop use.

TABLE I *Radioactive Sources Most Commonly in Use in Britain and the U.S.S.R.*

Source	Half life	Gamma energy, MeV	Steel thickness (or equivalent) penetrated	Exposure time for 1 in steel, 1 curie, fast film, film density 1·5 at 18 in source to film distance	Approx. weight of lead container for tolerance dose rate (6·25 mr per hour) at surface	
					1 curie	5 curies
Thulium 170	129 days	0·084	For aluminium, light alloys, plastics, etc. Thin sections only	0·5 in Al, 4 hours	Relatively very small (portable)	
Iridium 192 ..	74·4 days	0·41	½–2½ in 12–62 mm	40 min	25 lb (11 kg)	34 lb (15 kg)
Cobalt 60 ..	5·27 years	1·25	1–6 in 25–150 mm	8 min	600 lb (275 kg)	830 lb (375 kg)
Radon	3·8 days	0·6 1·12 1·76	1–6 in 25–150 mm	8 min	—	—
Tantalum 182 ..	111 days	1·2	1–5 in 25–125 mm	20 min	600 lb (275 kg)	830 lb (375 kg)
Europium 152 ..	13 years	1·1	2–4 in 50–100 mm	No data available in United Kingdom		
Caesium 137 ..	30 years approx.	0·667	¾–4 in 19–100 mm	35 min	85 lb (38 kg)	120 lb (55 kg)

TABLE II *Cobalt Sources Used in Radiography.* (August, 1955.)

U.S.S.R.*	U.K.	
2,163	563	In industry and government departments† excluding structural engineering.
68	11	Research in techniques and metallurgy†
268	14	Education and training†
184	18	Structural engineering†
130	—	Others.

* U.S.S.R. figures were given to the author by delegates to the International Conference in Geneva.
† U.K. figures are compiled from the reports of technical (area) representatives of Nuclear Engineering Limited.

HIGH-INTENSITY RADIOGRAPHIC EQUIPMENT

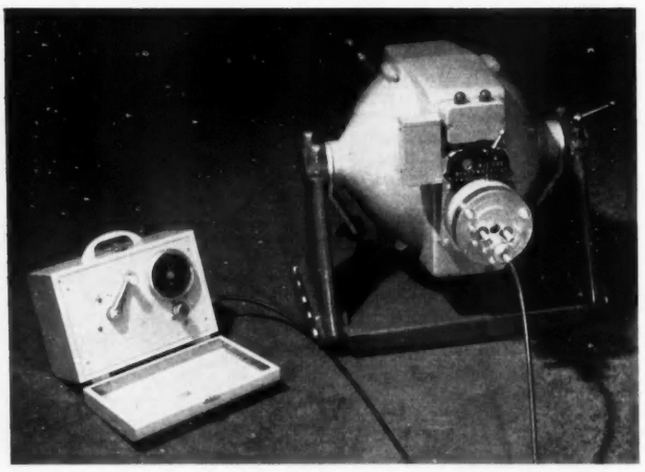


Fig. 10 (right) Soviet GUP 0·5 500 millicurie container for cobalt or caesium. Short-distance exposure control or handling tongs (on the right) are used.

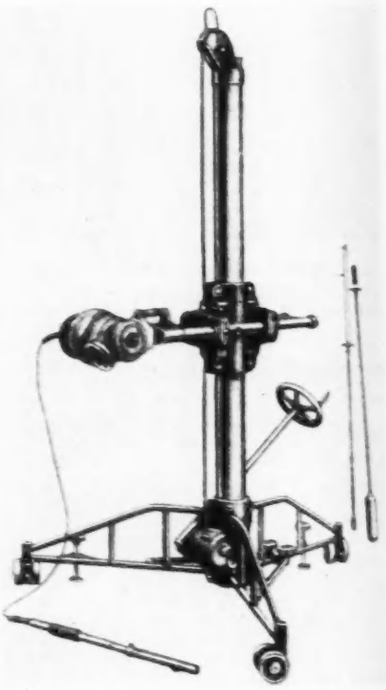


Fig. 11 (left) A British 10 curie cobalt radiographic unit (CR 10·000) with remote-control metering apparatus. The unit is designed to provide safety near the surface of container when the source is retracted, but can only be operated by remote control. Three sources can be housed and selected for use.

Fig. 12 (right) GUP50 radiographic container as used in the U.S.S.R. The source is moved from storage by compressed air to exposure head (right).

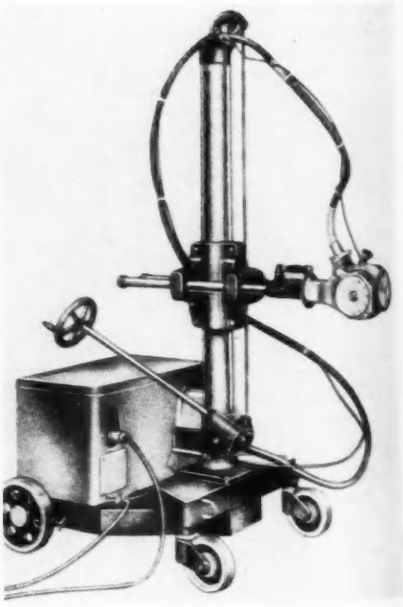


Fig. 13 (left) British 500 millicurie cobalt container (C.R. 500), set up for underwater radiography.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

BIRMINGHAM
"Electric Melting Furnaces," by W. L. Harrison. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2. Wed., 9 April, 7.30 p.m.

British Institution of Radio Engineers

LONDON
"Factors in the Design of Airborne Doppler Navigation Equipment," by E. G. Walker. London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Tues., 15 April, 6.30 p.m.*
NEWCASTLE UPON TYNE
Annual General Meeting and Film Evening. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 9 April, 6 p.m.

British Interplanetary Society

LONDON
"Problems of Handling Large Missiles," by F. R. F. Taylor Caxton Hall, off Victoria Street, S.W.1. Sat., 5 April, 6 p.m.

Building Centre

LONDON
Films: "Forming of Metals," exhibited by Shell-Mex and B.P. Ltd. Wed., 16 April, 12.45 p.m.

Chemical Society

ST. ANDREWS
"Some Organic Compounds of the Transition Metals," by Dr. P. L. Pauson. St. Andrews and Dundee Branch. Chemistry Department, St. Salvator's College, St. Andrews. Fri., 18 April, 5.15 p.m.

Combustion Engineering Association

LONDON
"Measurement of Oxygen in Flue Gases," by F. T. Ashmore; and "Measurement of Oxygen in Feed Water," by M. S. Timms, at 10 a.m. "Chemical Engineering in the Coal Industry," by Dr. G. I. Jenkins, at 2.30 p.m. Southern Region. St. Ermin's Hotel, Caxton Street, S.W.1. Thurs., 10 April.

East Midlands Metallurgical Society

NOTTINGHAM
Annual General Meeting. "Continuous Rolling of Stainless Steel Strip," by J. A. Campbell. Nottingham and District Technical College, Shakespeare Street, Nottingham. Thurs., 10 April, 7.30 p.m.

Helicopter Association of Great Britain

LONDON
"Powered Lift Systems," by Charles H. Zimmerman. Royal Aeronautical Society, 4 Hamilton Place, W.1. Fri., 11 April, 6 p.m.

Illuminating Engineering Society

LEEDS
Annual General Meeting and Social Evening. Leeds Centre. Mansion House, Roundhay Park, Leeds, 8. Fri., 11 April, 7 p.m.
LIVERPOOL
Annual General Meeting. Liverpool Centre. Liverpool Passenger Transport Office, 24 Hatton Garden, Liverpool, 3. Tues., 15 April, 6 p.m.
NOTTINGHAM
"Display and Small Store Lighting," by J. R. Just. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy Row, Nottingham. Thurs., 10 April, 6 p.m.*

Incorporated Plant Engineers

BRISTOL
"The Plant Engineer and Work Study," by H. A. Gomm. Western Branch. Grand Hotel, Bristol. Wed., 9 April, 7.15 p.m.
DUNDEE
"Uses of Electronics," by R. B. Smith Dundee Branch. Mathers Hotel, Dundee. Mon., 7 April, 7.30 p.m.
GLASGOW
"Design of Industrial and Hospital Engineering Services," by E. S. Hancock. Glasgow Branch. Scottish Building Centre, 425-427 Sauchiehall Street, Glasgow. Thurs., 10 April, 7.15 p.m.
LIVERPOOL
Branch Chairman's Address. Merseyside and North Wales Branch. Exchange Hotel, Liverpool. Thurs., 10 April, 7.15 p.m.
MANCHESTER
"Modern Developments in Diesel Rail Transport," by A. Montague. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 8 April, 7.15 p.m.
NEWCASTLE UPON TYNE
"Lubrication," by W. P. F. Jolly. North East Branch. Roadway House, Oxford Street, Newcastle upon Tyne. Thurs., 10 April, 7 p.m.

Institute of Fuel

LONDON
"Lacq: Its Problems and Potentialities," by André Blanchard. Institution of Civil Engineers, Great George Street, S.W.1. Thurs., 10 April, 5.30 p.m.*
MANCHESTER
Annual General Meeting, at 2.15 p.m. "Britain's Fuel and Power Problems," by Engineer Rear-Admiral Sir Sydney Frew, at 2.30 p.m. North Western Section. Engineers' Club, Albert Square, Manchester. Wed., 9 April.

Institute of Marine Engineers

BIRMINGHAM
"Design and Application of Servo-Operated Pressure Control Valves," by M. F. Jackson. West Midlands Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Thurs., 10 April, 7 p.m.*

Institute of Physics

LONDON
"High-Speed Radiography"—"Tubes and Mechanisms," by R. F. Thumwood; and "Circuits and Evaluation," by R. Meakin. Fri., 18 April, 6 p.m.*

Institute of Road Transport Engineers

BATH
Annual General Meeting. Western Centre. Angel Hotel, Westgate Street, Bath. Thurs., 10 April, 7.15 p.m.*
BIRMINGHAM
Annual General Meeting. Midlands Centre. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2. Tues., 8 April, 7.30 p.m.
CARDIFF
Annual General Meeting. South Wales Centre. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 11 April, 7 p.m.
MANCHESTER
Annual General Meeting. East Regional Centre. 90 Deansgate, Manchester. Mon., 14 April, 7.30 p.m.

Institution of Chemical Engineers

BIRMINGHAM
"Synthetic Rubber Plants," by A. E. W. Bailey. Midlands Branch. Midland Institute, Paradise Street, Birmingham Wed., 16 April, 6.30 p.m.

Institution of Civil Engineers

LONDON
"Construction of Circulating Water Pump House at Cowes Generating Station, Isle of Wight," by R. H. Coates and L. R. Slade. Tues., 15 April, 5.30 p.m.*
MANCHESTER
"Jodrell Bank Radio Telescope," by H. C. Husband. North Western Association. Engineers' Club, Albert Square, Manchester. Thurs., 10 April, 6.30 p.m.

Institution of Electrical Engineers

LONDON
Informal Evening on "Ultra-High-Frequency Test Transmissions." Radio and Telecommunication Section. Wed., 9 April, 5.30 p.m.*
"Radio Observations on Artificial Satellites," by J. A. Ratcliffe. Thurs., 10 April, 5.30 p.m.*
Discussion on "Future Trend of Installation Inspection," opened by Forbes Jackson. Mon., 14 April, 5.30 p.m.*
"ZETA," by R. Carruthers. London Graduate and Student Section. Fri., 11 April, 6.30 p.m.*
BELFAST
"An Asymmetrical Induction-Motor Winding for 6:3:2:1 Speed Ratios," by Professor G. H. Rawcliffe and B. V. Jayawant. Northern Ireland Centre. Civil Engineering Department, David Keir Building, Queen's University, Belfast. Tues., 15 April, 6.30 p.m.
EDINBURGH
"Broad-Band Slot-Coupled Microstrip Directional Couplers"; "Re-Entrant Transmission Line Filter Using Printed Conductors"; and "Application of Printed-Circuit Techniques to the Design of Microwave Components," by J. M. C. Dukes. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Mon., 7 April, 7 p.m.
GLASGOW
"Storage and Manipulation of Information in the Brain," by Dr. R. L. Beurle. South West Scotland Sub-centre. Royal College of Science and Technology, George Street, Glasgow, C.1. Tues., 8 April, 7 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"Turbo-Car Progress," by P. A. Phillips. North East Branch. Northern Architectural Association, 6 Higham Place, Newcastle upon Tyne. Mon., 14 April, 7.15 p.m.

Institution of Heating and Ventilating Engineers

BRISTOL
Symposium on "Nuclear Energy and Electricity for Heating." South Western Branch. Library, R.W.A. School of Architecture, Bristol. Tues., 8 April, 6.30 p.m.

Institution of Highway Engineers

LONDON
Symposium on "Trends in Road Foundations." Institution of Structural Engineers, 11 Upper Belgrave Street, S.W.1. Fri., 11 April, 5.30 p.m.*

Institution of Locomotive Engineers

LONDON
"Steels for Railway Purposes," by W. Barr and J. Dearden. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, S.W.1. Wed., 16 April, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
Discussion on "Problems Arising from Steam Conditions in Nuclear Power Stations, with Special Reference to Turbine, Boiler and Auxiliary Plant Design and to Nuclear-Fossil Fuel Cycles." Steam Group. Wed., 9 April, 6 p.m.*
"Clean Rooms for the Assembly of Electrical and Mechanical Instruments," by H. G. Harris. In conjunction with the Industrial Administration and Engineering Production Group. Fri., 11 April, 6 p.m.*
"Petrol Injection": papers by Errol J. Gay, E. W. Downing, and H. Heinrich and H. Stoll. Tues., 15 April, 4.30 p.m.
CHESTERFIELD
"The Commercial Gas Turbine," by E. O. Kohn. East Midlands Branch. College of Technology, Chesterfield. Wed., 9 April, 7.30 p.m.

Institution of Production Engineers

BELFAST
"Work Study," by A. J. Speakman. Northern Ireland Section. Kensington Hotel, Belfast. Thurs., 10 April, 7.30 p.m.
CHATHAM
Annual General Meeting at 7 p.m. Film Display at 7.30 p.m. Rochester Section. Prince of Wales Hotel, Chatham. Thurs., 10 April.
NEWCASTLE UPON TYNE
Annual General Meeting and Tour of the College. Newcastle upon Tyne Section. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 14 April, 7 p.m.

Institution of Public Health Engineers

LONDON
"Pollution of Underground Water," by Dr. G. Carter. Caxton Hall, off Victoria Street, S.W.1. Wed., 16 April, 6 p.m.

Institution of the Rubber Industry

LONDON
Annual General Meeting and Supper. London Section. Criterion, Piccadilly, W.1. Tues., 8 April, 6.30 p.m.
MANCHESTER
Annual General Meeting and Social Evening. Manchester Section. Engineers' Club, Albert Square, Manchester. Mon., 14 April, 6.45 p.m.

Junior Institution of Engineers

LONDON
"Industrial Applications in Connection with Television," by T. M. C. Lance. Fri., 11 April, 7 p.m.*

Leeds Metallurgical Society

LEEDS
"Pressure Die Casting," by G. Kelly. Offices of the West Yorkshire Foundries Ltd., Leeds. Thurs., 10 April, 7.15 p.m.

Liverpool Metallurgical Society

LIVERPOOL
Annual General Meeting. "The Micro-Mechanism of Fracture in Mild Steels," by Professor W. S. Owen. Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool. Thurs., 10 April, 7 p.m.

Newcomen Society

LONDON
"Essex Windmills," by Rex Wailes. Wed., 9 April, 5.30 p.m.

Non-Destructive Testing Society of Great Britain

BIRMINGHAM
"Gamma Radiography," by G. H. Sanders. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2. Sat., 12 April, 10.30 a.m.

Reinforced Concrete Association

LONDON
"Recent Developments in Prestressed Concrete in Belgium," by Professor D. Vandepitte. Institution of Structural Engineers, 11 Upper Belgrave Street, S.W.1. Wed., 23 April, 6 p.m.*

Royal Aeronautical Society

LONDON
"Guided Weapons," by Dr. R. Cockburn. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, S.W.1. Thurs., 10 April, 6 p.m.*
"Problems of Vertical Take-Off," by Dr. C. T. Hewson. Section Lecture. Tues., 15 April, 7 p.m.

Royal Meteorological Society

LONDON
Annual General Meeting. Presidential Address: "Transfer Across the Earth's Surface and Through the Air Above," by Professor P. A. Sheppard. Wed., 23 April, 5 p.m.*

Royal Society of Arts

LONDON
"Prestressed Concrete," by G. W. Kirkland. First of three lectures. Mon., 14 April, 6 p.m.

Société des Ingénieurs Civils de France (British Section)

LONDON
"Lacq: Its Problems and Potentialities," by André Blanchard. Institution of Civil Engineers, Great George Street, S.W.1. Thurs., 10 April, 5.30 p.m.*

Society of Chemical Industry

LONDON
Annual General Meeting and Spring Lecture on "Corrosion Research and Its Industrial Background," by W. H. J. Vernon. Corrosion Group. Wed., 16 April, 6.30 p.m.

Society of Instrument Technology

BIRMINGHAM
Annual General Meeting. Presidential Address by Sir Harold Hartley, G.C.V.O. Midland Section. Regent House, St. Phillips Place, Colmore Row, Birmingham, 3. Fri., 11 April, 7 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"From Furnace to Mould." Papers by T. McCulloch, T. Urie and R. McDonald. Fri., 11 April, 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, W.C.1. (LANgham 5927.)
British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1. (MUSeum 1901.)
British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1. (TATe Gallery 9371.)
Building Centre, 26 Store Street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke Street, St. James's, London, S.W.1. (WHItehall 5536.)
East Midlands Metallurgical Society. Apply to Mr. P. A. Blackwell, 57 Derby Lane, Derby.
Helicopter Association of Great Britain, 4 The Sanctuary, London, S.W.1. (ABBey 5160.)
Illuminating Engineering Society, 32 Victoria Street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1. (LANgham 7124.)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, E.C.3. (ROYal 8493.)
Institute of Physics, 47 Belgrave Square, London, S.W.1. (BELgravia 6111.)
Institute of Road Transport Engineers, 69 Victoria Street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George Street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland Place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, S.W.1. (SLOane 3158.)
Institution of Highway Engineers, 47 Victoria Street, London, S.W.1. (ABBey 3891.)
Institution of Locomotive Engineers, 28 Victoria Street, London, S.W.1. (ABBey 6672.)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield Street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria Street, London, S.W.1. (VICtoria 3017.)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W.8. (BAYswater 9101.)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1. (VICtoria 0786.)
Leeds Metallurgical Society. Apply to Dr. P. Feltham, The University, Leeds.
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road St. Helens, Lancs. (St. Helens 5879.)
Newcomen Society, Science Museum, Exhibition Road, London, S.W.7. (KENsington 1793.)
Non-Destructive Testing Society of Great Britain, 2 Tomswood Terrace, Barkingside, Essex. (HAInault 5488.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504..)
Royal Aeronautical Society, 4 Hamilton Place, London, W.1. (GROsvenor 3515.)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Société des Ingénieurs Civils de France (British Section), 82 Victoria Street, London, S.W.1. (Victoria 6838.)
Society of Chemical Industry, 14 Belgrave Square, London, S.W.1. (BELgravia 3681.)
Society of Instrument Technology, 20 Queen Anne Street, London, W.1. (LANgham 4251.)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C.2. (Central 5181.)

Engineering at Home

STEREOPHONY ON DISC

Stereophonic recording and reproduction attempts to create for the listener the aural illusion that he is listening to original sounds from a variety of sources at different directions and distances from him, when, in fact, they are coming from two loudspeakers. In a recent article on this page (ENGRG., 14 Feb. '58), experiments in stereophony using dual-track magnetic tape were mentioned. However, discs can be used instead. Tape is technically the superior medium but discs have the advantage of lower cost and ease of handling. An account of some of the techniques required when tape is not used was given in a talk "Stereophonic Recording on Gramophone Discs," by Mr. H. A. M. Clark. The talk was part of an informal evening held by the Radio and Telecommunications Section of the Institution of Electrical Engineers.

A basic method for the provision of two channels in a single groove on a disc was described by A. D. Blumlein in 1932. Two alternatives were put forward. In each case the movements of the stylus corresponding to the left and right channels were in two directions mutually at right angles. In one proposal, the directions were parallel to and perpendicular to the surface of the wax. In the other, the two directions were each at 45° to the surface of the wax. It is possible to show that either system is equivalent to the other with the addition of a summing and differencing process of the two electrical inputs, having due regard to the phases. When reproducing such records a pick-up is used which has a stylus capable of movement in any direction in the plane perpendicular to the direction of movement of the disc, the two electrical outputs being obtained by resolution of the complex stylus movement along the same axes as those of the cutter. In the ideal case there will be no cross-talk between the two channels during the process of recording and reproducing. Records of both types were made in 1933, at 78 r.p.m., and satisfactory stereophonic reproduction was achieved.

During the past five years the arrangements described by Blumlein have been re-examined, and modern recording instruments have been designed for cutting a complex track to present-day microgroove standards. The use of lateral and vertical directions for the two channels has been developed by some companies in Great Britain, Germany, and Denmark. The 45° system has been favoured by other companies in Great Britain and the United States.

For the latter system it has been claimed that the relative phases of the two channels can be so selected that stylus movement in the lateral direction represents the algebraic sum of the left and right channels. Thus a simple orthodox pick-up will produce the total musical content. Such a record could be said to be "compatible" in that it would give a "monaural" reproduction when played on a normal reproducer, but would give stereophonic reproduction on a reproducer having a complex pick-up and two loudspeaker channels.

Mr. Clark pointed out that the 45° system has the additional advantage that noise and distortion, which are different for laterally and vertically cut recordings, are averaged between the final left and right channels. Any distinction between the channels would be undesirable. This feature of the 45° system, together with the possibility of compatibility, led the author to suggest that it was the system that should be preferred.

OLD HOUSES TO NEW

Last week Mr. H. Brooke, Minister of Housing and Local Government, opened a demonstration showing how soundly built old houses can be converted into flats with the aid of grants. The houses on show are about 90 years old and had no bathrooms, hot water, or internal w.c. They are in Cedarne Road, Fulham, London, S.W.6. All the properties on one side of the street are owned by Fulham Borough Council, who are undertaking the conversion.

The conversions have been effected by dealing with the houses in pairs, cutting through party walls on each floor and removing the stairs from one house. Flats are planned over the floors of two houses, and bathrooms, fuel cupboards and lobbies to kitchens are provided in the space formerly occupied by one of the staircases. The remaining staircase in each pair of houses provides access. Each flat is made self contained by a small amount of internal partitioning. Costs are set out in the table together with the grants.

All the new flats and flatlets have been made self-contained, having bathrooms with wash basin and w.c., working kitchens, gas-ignited approved solid fuel grates, hot water systems from electric immersion heaters in cylinders in the kitchens, ventilated food cupboards and fuel stores. No damp course existed and rising damp has been prevented by the use of siphonic tubes. Grants can be made available to private owners for similar schemes of conversion.

TABLE:—*Costs and Grants for Flat Conversion*

Type of flat	Conversion cost	Grant
	£	£
Bed-sitting room flats:		
Area 260 sq. ft	550	275
Area 310 sq. ft	598	299
One-bedroomed flat	526	263
Two-bedroomed flat	648	324
Three-bedroomed flat	690	345

DOVER GETS CHANNEL TWO

The B.B.C. announces that, with the approval of the Postmaster General, low power television stations will be installed at Swingate, near Dover, and in Folkestone. The difficulties that had arisen in finding wavelength channels on which these stations could operate without causing interference elsewhere have now been overcome and both stations will be put into service as quickly as possible. The solution does, however, restrict the power of the stations. This will limit the signal strength available in Hythe, but it is hoped that viewers there will get satisfactory reception from one or other of the new stations.

In order to provide a service in the Dover area without delay, a temporary station is being installed at the Swingate site. It will come into service on 21 April and will be on the same channel as the permanent station—Channel 2 (vision 51·75 Mc/s, sound 48·25 Mc/s). It will use vertical polarisation. The coverage of the permanent Dover station is expected to include Deal and Ramsgate. The effective radiated power will vary between 0·25 kW and 1 kW, with a maximum towards those towns.

The station in Folkestone will use a "satellite" transmitter developed by the B.B.C. The equipment is designed to be mounted out of doors and incorporates a receiver to pick up signals from another station and a transmitter to rebroadcast them in a different channel. In this case the transmission will be on Channel 4 (vision 61·75 Mc/s, sound 58·25 Mc/s), with horizontal polarisation. The effective radiated power will be 10 watts in the direction of Folkestone.

SPINNING DRY

For 35 years Frigidaire division of General Motors Limited, London, have only supplied and manufactured household refrigerators and commercial refrigeration equipment. Now as part of an expansion programme, the company are making a spin drier, called the "Cascade."

Clothes to be dried are put in a rotating drum driven by an electric motor. Water is extracted through slots in the centre of the drum wall. In the first half-minute 85 per cent of the water is extracted, by four minutes the clothes are dry enough for ironing. The machine is started by closing the lid and stopped either by a thermal cut out device, which operates when the spinning cycle is ended, or by the lid being raised. In the latter case an automatic safety brake is applied to the drum and brings it to rest in ten seconds. The capacity of the drum is 6 lb dry weight.

The drier stands 25 in high and has a diameter of 15 in. It weighs 53 lb and can be wheeled about. A steel drum with a diameter of 9¾ in is used, the speed of rotation being 2,800 r.p.m.

GUIDE ON HANDSAWS

A series of booklets, the "Handguide series," has been sponsored by Spear and Jackson Limited. The first, *Handsaws and Sawing*, by Mr. A. W. Lewis, of Loughborough Training College, has just been published. For 2*s.* 6*d.* it can be obtained from the company, at Savile Street, Sheffield, 4. Rip, cross-cut, panel, tenon, and dovetail saws are illustrated, and their salient points described. Explanations follow of how a saw cuts and how to cut with a saw; the different uses of the various types are then dealt with.

Later in the booklet some of the more unusual types—the coping, bow, flooring, compass, keyhole, and cross-cut saws are described and their method of use outlined. Saw maintenance and the setting and sharpening of saws follows, and the book concludes with a description of how to make a small coffee table.

The book is copiously and well illustrated and forms a miniature textbook for schools. It is published by Educational Productions Limited.

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